THE FARMER'S & MECHANICS MANUAL

G. M. Patchin

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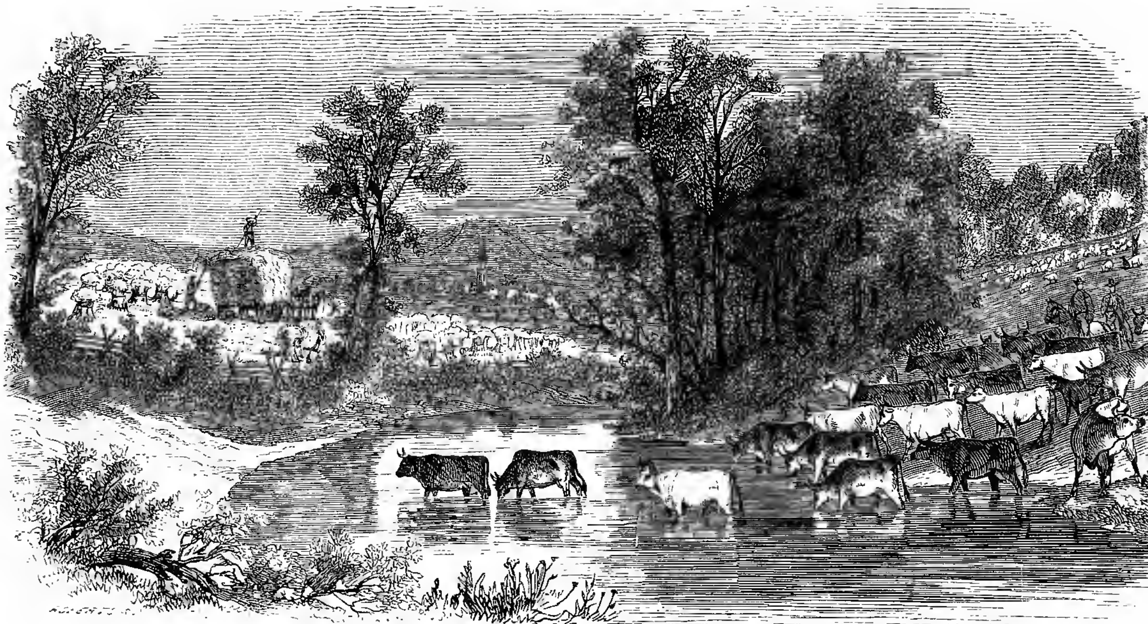

HARVEST TIME.

THE

FARMERS' AND MECHANICS'

MANUAL.

WITH MANY VALUABLE TABLES FOR MACHINISTS, MANUFACTURERS, MERCHANTS, BUILDERS, ENGINEERS, MASONS, PAINTERS, PLUMBERS, GARDENERS, ACCOUNTANTS, ETC.,

BY W. S. COURTNEY.

REVISED AND ENLARGED

BY GEORGE E. WARING, JR.,

AUTHOR OF "ELEMENTS OF AGRICULTURE," "DRAINING FOR PROFIT AND FOR HEALTH," "EARTH CLOSETS: HOW TO MAKE AND HOW TO USE THEM," AND FORMERLY AGRICULTURAL ENGINEER OF THE CENTRAL PARK, NEW YORK.

TWO HUNDRED ILLUSTRATIONS.

SOLD ONLY BY SUBSCRIPTION.

NEW YORK:

E. B. TREAT & CO., 654 BROADWAY;

TREAT & LILLEY, CHICAGO; E. HANNAFORD & CO., CINCINNATI; A. H. HUBBARD, PHILA.; A. L. TALCOTT & CO., PITTSBURG; G. P. HAWKES & CO., BOSTON; H. H. BANCROFT & CO., SAN FRANCISCO; J. H. HUMMEL, NEW ORLEANS; J. C. DERBY, AUGUSTA, GA.

PREFACE.

There are few persons, no matter what their calling or their education, who do not occasionally find themselves at a loss for information of the commonest kind, on any of the subjects pertaining to the practical arts of daily life—knowledge which was, perhaps, familiar to them in their schoolboy days, but which has been forgotten or become obscured through the lapse of years. For example, how few persons can tell, without consulting books, the cubic inches contained in a bushel, the square yards in an acre, or how to measure the contents of a corn crib, or gauge a cistern. Nor is the inability to do so any reflection upon either their native capacity or their education. It is simply impossible to carry all these things in the memory so as to apply them when occasion requires. Hence the necessity for "Hand-Books," "Mechanics' Assistants," "Pocket Companions," &c.

Besides the labor involved in the almost daily necessity of calculating arithmetical, mensural, and other results, and the constant liability to error to which even the competent scholar is subject, the *time* required in the process, in this age, when time has emphatically acquired a money value, is no inconsiderable desideratum. Hence the necessity for "Ready Reckoners," "Pocket Accountants," "Calculators' Assistants," &c.

In presenting this volume, a chief aim of the author was so to combine the Manual with the Reckoner, as to furnish the inquirer, in brief, with all the necessary rules and *data* and the elementary facts and axioms relating to almost every branch of industrial science, and particularly that of agriculture, and, at the same time, whenever it was possible, to compute and tabulate the results for him in the same connection. Hence he will find in the ensuing pages the axiomatical or elementary propositions, the *data*, the standards, the units, &c., of almost every useful and practical art with which the farmer may have to deal, clearly stated, together with their simplest rules, illustrated by examples and solutions, and, wherever it was practicable, the arithmetical results calculated and tabularized.

Those who consult this book must remember that it is not a work of *recipes*, *prescriptions*, or of *directions* and *advice* as to the best mode of conducting any or all the various operations pertaining to agriculture, &c. But they will bear in mind that the subjects of which this book treats are, for the most part, *facts and figures*—assured analyses and demonstrations—about which there can be no dispute. The design was to produce a work of substantial and enduring value, and of universal application and use—something in the sphere of agriculture corresponding to Haswell in Engineering, or Fairbairn in Mechanics. How far the author's labors have tended to that end remains to be tested by experience. He is sanguine of their ultimate fruition.

So vast is the domain of agriculture, that there are few of the mechanic arts of which the farmer does not require some information, and which he is often compelled to seek through many books and journals. He is, in a certain sense, encyclopediac in his science and use. Hence many subjects upon which he may require elementary knowledge and the assistance of computations may have escaped the vigilance of the author.

When a friend first suggested to the author the design of such a work, the latter had no adequate conception of the labor involved in such an undertaking. Although many of the tables were supplied or compiled from other authors, yet the labor involved in those he himself calculated and arranged was prodigious. Besides, the composition or type-setting of the matter was of the most tedious, difficult, and expensive kind, so that the volume of matter included within the covers would seem to bear no just proportion to the price the publisher is obliged to charge for it. Books much larger, and of many more pages of the ordinary composition, can be afforded at a much less cost. Withal, however, the author commends it to the favorable regard of those to whom it is addressed.

TO THE PRACTICAL READER.

Having been long engaged in the various occupations into which a life of combined farming and engineering is quite sure to lead any man of a practical turn of mind, I look back with regret on the days wasted in making long calculations to decide some simple question of size, or form, or quantity. Many a long day have I hunted through alcoves full of practical hand-books at the Astor Library, —scouring now the field of Agriculture, now of Mechanics, and now of Hydraulics,—often disappointed in my search, and compelled to go home and work far into the night, pursuing, through the long lanes of square and cube roots, the phantom of some every-day question of the discharge of water through pipes, the strength of material, or the resistance in ploughing.

I have always found less assistance than I had a right to expect from works written with the professed object of telling me what I wanted to know. After hunting them through, I have generally come to the conclusion that they contain almost everything *except* what I am looking for.

Certainly all that I have hitherto seen have been sadly incomplete.

Finally, I quite accidentally became acquainted with Mr. Courtney's Manual, and I found it much more nearly what it professes to be than any book that I had hitherto seen, for, although he very modestly complains of its incompleteness, it is undoubtedly much more thorough and accurate than are most works of its class.

The idea occurred to me, that by bringing my experience in the use of such books to bear upon the completion and amendment of Mr. Courtney's work, I might render a good service to the thousands who have almost daily occasion to consult a book of this character;—and in some degree make up for the loss that the community sustained in his death, although I cannot hope to bring to the task either the patience or the experience that constituted his great merit as a compiler.

It would be presumption to claim that, even in its enlarged and corrected condition, this book is complete, and all that could be desired, for there are more subjects of quite general interest to farmers and mechanics than could be properly *catalogued* in a book of this size. All that is claimed is, that so far as it goes it is correct; and that it goes as far, and in as many directions, as is compatible with its size and purpose.

The importance of having such a book as this always at one's elbow is very much greater than would at first sight be supposed by one who has not known the convenience of it.

How often, in farming, do we wish that we could know, on the spot, how to estimate the weight of hay in various conditions in the mow; the weight of cattle by measurement; the capacity of a grain bin; the weight of a piece of timber, or of a load of manure; the distance apart to which to set trees or plants in order to get a certain number within a certain space; the size of an irregular field. How often in mechanics do we need to know the strength and measurement of masonry; the contents of cisterns and small vessels; the area of circles; the quality of cements; the *power* value of fuel; the weight of bar iron, or of lead pipe; the fusing heat of metals; the strength of materials; or the board measure of scantling.

And, worst of all, how sadly we accustom ourselves to get along without knowing these things! How much we lose by *guessing* instead of *knowing!*

The object of this book is to put it within the power of every practical man to *know* these details;—to leave less to guessing, and to enable him to guide his daily operations by the light of positive knowledge. If it accomplishes this purpose, neither Mr. Courtney nor I will have worked in vain.

In addition to the many tables and statements of valuable facts with which the book abounds, I have thought it advisable to review very carefully all of its "agricultural" matter, and to add what I could, in the space allowed to me, that might be of interest to those farmers who care to look a little beyond the mere question of dollars and cents in farming, and of value to those who believe (as, happily, a yearly increasing number do believe) that the road to surer and greater profit lies through the door that Science and Common Sense—the guardian angels of Agriculture—hold open to them.

It has not been possible to do much in this direction, for the subject is a very extended one, but I think that many a young farmer, if he will consider well the principles that are laid down under the headings of "Plants," "Soils," and "Manures," will at least feel a desire to learn more of the simple truths which lie at the foundation of his practice.

I am sure, also, that it is not too much to say, that a careful study of the directions and the reasons for Tile-Draining will richly repay any occupier of cold, wet land for the purchase of the book.

This is a subject which, in this country at least, is still in the very early infancy of its progress. Not one acre in ten thousand of the land that it would pay well to drain in the best manner, has yet felt the benefit of the operation; and not one farmer in a thousand has the faintest conception of the fact,—a fact that ample experience, here and in Europe, has fully demonstrated,—that he can no more *afford* to farm an undrained heavy soil, than a carpenter can afford to work with a dull tool.

I have introduced another novelty into the work, under the head of "The Dry Earth System." This is a bantling that has raised its head within a very few years, and is only now coming to be recognized at its full value; but it is ushered before our attention with all the force that consideration of decency, health, and economy can lend; and the most thoughtful attention is asked for its claims. It is really the coming Reform, and promises more for civilization, and for national prosperity, than any improvement that has yet been brought to the notice of the public.

To sum up, then: this book is offered as containing more that has been proven by long use to be of value; more that it is most necessary for every farmer and mechanic to know; and more of promising novelty, than any other that has ever been presented to the farmers and mechanics of America.

It is complete in every particular in which it is possible for such a book to be complete, and, in addition to this, it is sufficiently suggestive in many other respects to induce its readers to read more, to think more, to experiment more, and to become more intelligent and more successful in the management of their business, as well as really happier and wiser men.

If it should be thought that I claim too much for a single Hand-Book, which is mainly filled with dry details concerning the measurement of boards, and the spacing of trees in an orchard, I trust that I shall at least not be condemned as an enthusiast until the reader has taken the trouble to examine carefully what I have to say, and to consider well to what better things the helping hand of Nature may lead him if he has the wisdom to heed its beckonings.

GEO. E. WARING, JR.

OGDEN FARM, NEWPORT, R. I., September, 1868.

LIST OF ILLUSTRATIONS.

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COMMERCIAL ABBREVIATIONS.

@.,	At.	Fr't.,	Freight.
a/c.,	Account.	Inst.,	This month.
¢.,	Cents.	Int.,	Interest.
₶	Number.	Mdse.,	Merchandise.
Am't.,	Amount.	Mo.,	Month.
Ass'd.,	Assorted.	Net,	Without discount.
Bal.,	Balance.	No.,	Number.
Bbl.,	Barrel.	Pay't.,	Payment.
Blk.,	Black.	Pk'gs.,	Packages.
Cons't.,	Consignment.	Per *or* pr.,	By.
Dft.,	Draft.	Prem.,	Premium.
Disc't.,	Discount.	Prox.,	Next month.
E. E.,	Errors excepted.	Ps.,	Pieces.
Exps.,	Expenses.	Sunds.,	Sundries.
Fol.,	Folio.	Ult.,	Last month.
Fwd.,	Forwarded.		

EXPLANATION OF ARITHMETICAL CHARACTERS USED IN THIS BOOK.

$=$ *Equal;* as 12 inches $=$ 1 foot, or $4\times5=20$.

$+$ *Plus or more;* signifies addition, as $3+5+7=15$.

$-$ *Minus or less*; signifies subtraction, as $12-4=8$.

$\times$ *Multiplied by;* signifies multiplication, as $8\times7=56$.

$\div$ *Divided by;* signifies division, as. $56\div8=7$.

: :: : *Proportion*; as 2 : 4 :: 8 : 16; that is, as 2 is to 4 so is 8 to 16.

$\sqrt{}$ Prefixed to a number denotes that the *square root* of that number is requircd, as, $\sqrt{36}=6$.

$\sqrt[3]{}$ Prefixed to a number denotes that the *cube root* of that number is required, as, $\sqrt[3]{27}=3$.

^{2} Added to a number signifies that the number is to be *squared,* as 4^2 means that 4 is to be multiplied by 4.

^{3} Added to a number signifies that the number is to be *cubed,* as 4^3 means $4\times4\times4=64$.

. *Decimal point,* when prefixed to a number signified that that number has an unit (1) for lts denominator, as .1 is $\frac{1}{10}$, .2 is $\frac{2}{10}$, .12 is $\frac{12}{100}$, .125 is $\frac{125}{1000}$, &c.

$^\circ$ Signifies degrees: $'$ minutes, and $''$ seconds.

SEASONS, LONGITUDE, &c.

Spring. Summer.

Autumn. Winter.

To reduce longitude to time.

The English count their degrees of longitude east and west from Greenwich, which, owing to our early dependence upon the mother country for books and science, became extensively adopted in this country, and still prevails to a considerable extent, especially in our nautical charts, and works on navigation. But by an act of Congress, passed some thirty years ago, the meridian of Washington was established as the point of departure, and accordingly our maps, charts, &c., have since been adapted to that meridian.

The sun passes over a degree of longitude in 4 minutes —the 360° in 24 hours. Thus, when we travel west, or on a line with the sun, our watch is four minutes *fast* for every 60 geographical miles we travel. If we travel east, or on a line with the sun, it is four minutes *slow* for every degree we travel. Hence, when it is noon at Greenwich, that is, when the sun is on the meridian there, if we multiply 74°, the longitude of New York west from Greenwich, by 4, and subtract the result from 12 o'clock M., it will give the corresponding time at New York. Thus, $74° \times 4 = 296$ minutes, which, divided by 60, gives 4 hours and 56 minutes for the sun to travel from Greenwich to New York. Subtracting this from 12 o'clock (the Greenwich time) gives 7 o'clock and 4 minutes A.M. as the corresponding time at New York. So also by reverse, when it is noon at New York, it is 4 hours and 56 minutes past noon at Greenwich. Hence results the following

RULE.—Multiply the number of degrees, minutes, and seconds west or east of the given meridian by 4, reduce the product to hours, &c., and for west longitude subtract from 12 hours, and for east longitude add to 12 hours (*i. e.*, so many hours past 12), and the result will be the corresponding time.

EXAMPLE.—Required the time at longitude 50° 31′ west, corresponding to noon at Greenwich?

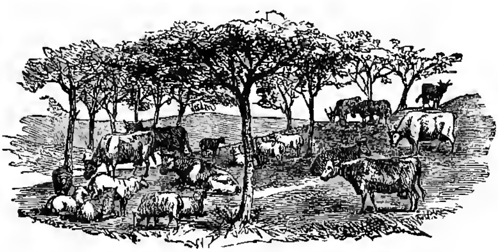
SOLUTION.—$50° 31' \times 4 = 3$ hours 22 min. 4 sec.—$12 = 8$ h. 37 min. 56 sec. A.M. *Ans.*

NOTE.—Time is both *apparent* and *mean*. The sun is on the meridian at 12 o'clock on four days only in the year. It is sometimes as much as 16¼ minutes before or after 12 when its shadow strikes the noon mark on the sun-dial. This is occasioned by the irregular motion of the earth on its axis and the inclination of its poles. This is called *apparent time*. *Mean time* is determined by the *equation* of these irregularities for every day in the year, and is noted in all good almanacs. The latter is the true or correct time. The foregoing rule is applicable to either.

When you buy an almanac, buy one that expresses on each calendar page the *mean time* when the sun reaches the meridian, or the shadow the noon-mark on the dial, and set your time-piece fast or slow as indicated in the almanac.

To ascertain the length of the day and night.

At any time in the year, add 12 hours to the time of the sun's setting and from the sum subtract the time of rising for the *length of the day.* Subtract the time of setting from 12 hours, and to the remainder add the time of rising the next morning for the *length of the night.* This rule is true of either apparent or mean time.



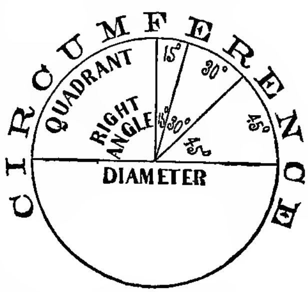
CIRCULAR OR ANGULAR MEASURE.

This Measure is used to measure angles or the arcs of circles. It is used in astronomy, geography, navigation, and surveying, and for calculating differences of time.

TABLE.

60 seconds (″)	make	1 minute,	marked	′
60 minutes	"	1 degree,	"	°
30 degrees	"	1 sign,	"	sig.
90 degrees	"	{ 1 quadrant,	"	quad.
		{ 1 right angle,	"	r. a.
4 quadrants or 12 signs	"	1 circumference or circle	"	cir.

NOTES.—1. The greatest distance across a circle is called its *diameter*. The distance around it is called its *circumference*. Any part of the circumference is called an *arc*.



2. If any circumference, whether large or small, be divided into 360 equal arcs, each arc is called a degree. The

degree is divided into 60 minutes, and the minute into 60 seconds. The length of a degree, minute, or second, depends on the size of the circle. If the size of the circle is increased or decreased, the length of the degree, minute, or second is also increased or decreased.

3. The greatest circumference of the earth's surface is about 24,930 miles; 1° of that circumference is one 360th of 24,930 miles, which is 69¼ miles.

4. A geographical or nautical mile is equal to 1′ of the earth's greatest circumference, which is found to be a little more than one statute mile and 49 rods.

5. Latitude is measured north or south from the equator on any meridian, and is expressed in degrees, minutes, and seconds; thus, 43° 17′ 31″ north lat. denotes a position 43° 17′ 31″ north from the equator.

6. The linear extent of a degree of longitude depends upon the latitude, and diminishes as the latitude increases; thus, at latitude 10° its extent is 359640 feet; at lat. 40° it is 280106 feet; and at lat. 80° it is only 63612 feet.

MEASURE OF TIME.

Time is the measure of duration.

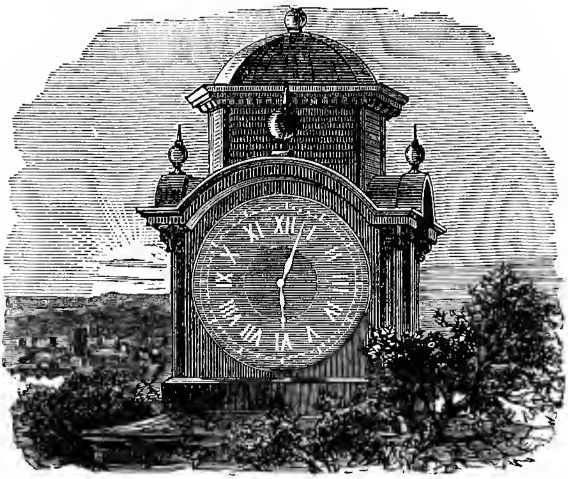


TABLE.

60 seconds (sec.)	make	1 minute,	marked min.
60 minutes	"	1 hour,	" h.
24 hours	"	1 day,	" da.
7 days	"	1 week,	" wk.
4 weeks 2 days, or 30 days	"	1 month,	" mo.

365 days, or 52 weeks 1 day 12 calendar months	make 1 year,	marked yr.
100 years	" 1 century,	" C.

The calendar year is divided as follows:

Season.	Months.	No. of days.	Abbreviations.
Winter	1. January	31	Jan.
	2. February	28 or 29	Feb.
Spring	3. March	31	Mar.
	4. April	30	Apr.
	5. May	31	——
Summer	6. June	30	Jun.
	7. July	31	——
	8. August	31	Aug.
Autumn	9. September	30	Sept.
	10. October	31	Oct.
	11. November	30	Nov.
Winter	12. December	31	Dec.
		365 or 366.	

NOTES.—1. The exact length of the solar year is 365 days 5 h. 48 min. 49 sec.; but, for convenience, it is reckoned 11 min. 11 sec. more than this, or 365 da. 6 h. = 365¼ days. This ¼ day in four years makes 1 day, which every fourth year (called Bissextile or leap year) is added to the shortest month, giving it 29 days. The numbers denoting leap years are exactly divisible by 4; as, 1856, 1860, 1864; except years whose number can be divided without a remainder by 100, but not by 400.

2. Owing to an error in the Julian calendar, it was decreed by the British Government that the day following the second day of September, 1752, should be called the fourteenth day of September, or that 11 days should be stricken from the calendar.

3. Time, previous to this decree, is called *Old Style* (O. S.), and since, *New Style* (N. S.). Russia still reckons time by the Old Style, hence their dates are 12 days behind ours.

4. In most business transactions 30 days are called a month, and 52 weeks a year.

5. The centuries are numbered from the commencement of the Christian era; the months from the commencement of the year; the days from the commencement of the month; and the hours from the commencement of the day (12 o'clock, midnight), and from mid-day or noon. A.M. denotes time before noon, M., at noon, and P.M., after noon. Thus, 9 o'clock A.M., May 23, 1860, is the end of the ninth hour of the 23d day of the fifth month of the 60th year of the 19th century.

6. A decade is a period of 10 years.

7. The *Lunar Cycle*, or *Golden Number*, is a period of 19 years, after which the changes of the moon return on the same days of the month.

8. The *Solar Cycle* is a period of 28 years, when the days of the week again return to the same days of the month.

To find the golden number or lunar cycle.

RULE.—Add 1 to the given year; divide the sum by 19, and the remainder is the golden number.

EXAMPLE.—What is the golden number for 1857?

SOLUTION.—1857+1÷19=97, rem. 15. *Ans.*

NOTE.—If 0 remain, it will be 19. Hence, in 1861, the changes of the moon occur on the same days of the month they did in 1842, 1823, 1804, &c.

TABLE *showing the number of days from any day in one month to the same day in any other.*

FROM	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
January.....	365	31	59	90	120	151	181	212	243	273	304	334
February....	334	365	28	59	89	120	150	181	212	242	273	303
March.......	306	337	365	31	61	92	122	153	184	214	245	275
April.......	275	306	334	365	30	61	91	122	153	183	214	244
May	245	276	304	335	365	31	61	92	123	153	184	214
June........	214	245	273	304	334	365	30	61	92	122	153	183
July........	184	215	243	274	304	335	365	31	62	92	123	153
August......	153	184	212	243	273	304	334	365	31	61	92	122
September...	122	153	181	212	242	273	304	334	365	30	61	91
October.....	92	123	151	282	211	243	273	304	335	365	31	61
November...	61	92	120	151	181	212	242	273	304	334	365	30
December...	31	62	90	121	151	182	212	243	274	304	335	365

EXPLANATION.—Find, in the left-hand column, the month from any day of which you wish to compute the number of days to the same day in any other month, and follow the line along until under the latter, and you have the required number of days. Thus, from the 12th of April to the 12th of October, is 183 days; from the 7th of March to the 7th of June, 92 days.

TABLE *for finding the number of days between two dates—new method.*

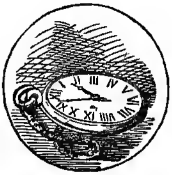
Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	32	60	91	121	152	182	213	244	274	305	335
2	33	61	92	122	153	183	214	245	275	306	336
3	34	62	93	123	154	184	215	246	276	307	337
4	35	63	94	124	155	185	216	247	277	308	338
5	36	64	95	125	156	186	217	248	278	309	339
6	37	65	96	126	157	187	218	249	279	310	340
7	38	66	97	127	158	188	219	250	280	311	341
8	39	67	98	128	159	189	220	251	281	312	342
9	40	68	99	129	160	190	221	252	282	313	343
10	41	69	100	130	161	191	222	253	283	314	344
11	42	70	101	131	162	192	223	254	284	315	345
12	43	71	102	132	163	193	224	255	285	316	346
13	44	72	103	133	164	194	225	256	286	317	347
14	45	73	104	134	165	195	226	257	287	318	348
15	46	74	105	135	166	196	227	258	288	319	349
16	47	75	106	136	167	197	228	259	289	320	350
17	48	76	107	137	168	198	229	260	290	321	351
18	49	77	108	138	169	199	230	261	291	322	352
19	50	78	109	139	170	200	231	262	292	323	353
20	51	79	110	140	171	201	232	263	293	324	354
21	52	80	111	141	172	202	233	264	294	325	355
22	53	81	112	142	173	203	234	265	295	326	356
23	54	82	113	143	174	204	235	266	296	327	357
24	55	83	114	144	175	205	236	267	297	328	358
25	56	84	115	145	176	206	237	268	298	329	359
26	57	85	116	146	177	207	238	269	299	330	360
27	58	86	117	147	178	208	239	270	300	331	361
28	59	87	118	148	179	209	240	271	301	332	362
29		88	119	149	180	210	241	272	302	333	363
30		89	120	150	181	211	242	273	303	334	364
31		90		151		212	243		304		365

NOTE.—To find from the above table the number of days between two dates, we give the following—

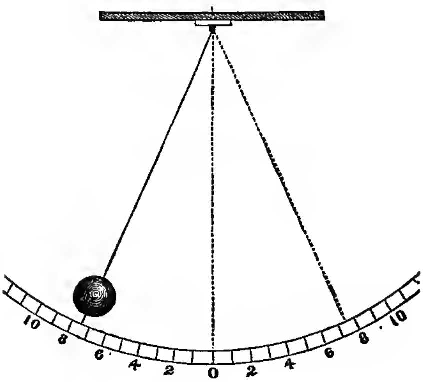
RULE.—I. When the dates are in the same year, subtract the number of days of the earlier date from the number of days of the later date; the result will be the number of days required.

II. When the dates are in consecutive years, subtract the number of days of the earlier date from 365, and add to the remainder the number of days of the later date; the result will be the number of days required.

When the year is a leap year, add one day to the result.



PENDULUMS.



The vibrations of pendulums are as the square roots of their lengths. The length of one that will vibrate seconds in New York, at the level of the sea, is 39.1013 inches.

To find the length of a pendulum for any given number of vibrations per minute.

RULE.—As the number of vibrations given is to the square root of 39.1013 inches, so is 60 to the square root of the length of the pendulum required.

EXAMPLE.—What is the length of a pendulum that will make 50 vibrations per minute?

SOLUTION.—50 : 6.25 (the sq. root of 39.1013) :: 60 : 7.5, then $7.5^2 = 56.25$ inches. *Ans.*

To find the number of vibrations per minute, the length of the pendulum being given.

RULE.—As the square root of the length of the pendulum is to 60, so is the square root of 39.1013 to the number of vibrations required.

EXAMPLE.—How many vibrations will a pendulum 64 inches long make in a minute?

SOLUTION.—8 (square root of 64) : 60 :: 6.25 (sq. root of 39.1013) : 46.875 vibrations. *Ans.*

TABLE *showing the planets, comparative size, &c., in the solar system.*

NAMES.	Mean Diameter.	Mean distance from the Sun.	Revolution ar'd the Sun.		Revolution on axis.			Velocity pr. minute in orbit.	Size—the Earth being 1.	Density: Earth being 1.	Light: Earth being one.
	Miles.	Miles.	yrs.	days	d.	h.	m.	Miles.			
THE SUN	883,246	......	...	..	25	9	59	....	1,412,921.100	0.252	in6n.
Mercury	3,224	36,814,000	...	88	1	0	5	1 827	0.053	1.120	6.680
Veous	7,687	68,787,000	...	224	..	23	21	1,338	0.909	0.923	1.911
The Earth	7,912	95,103,000	1	...	..	23	56	1,138	1.000	1.000	1.000
The Moon	2,180	95,103,000	1	...	27	7	43	38	0.020	0.615	1.000
Mars	4,189	144,908,000	1	321	1	0	37	921	0.125	0.948	0.431
Jupiter	89,170	494,797,000	11	215	..	9	56	496	1,456.000	0.238	0.037
Saturn	79,042	907,162,000	29	167	..	10	29	368	771.000	0.138	0.011
Uranus	35,112	1,824,290,000	84	6	1	13	83	259	80.000	0.242	0.003
Neptune	41,500	2,854,000,000	164	226	..	..	..	208	143.000	0.140	0.001

THE WEATHER.

The following table, and the accompanying remarks, originally formed by Dr. Herschel, and approved with some alterations by the experienced Dr. Adam Clarke, are the result of many years' close observation; the whole being on a due consideration of the attraction of the sun and moon, in their several positions respecting the earth, and will, by inspection, show the observer what kind of weather will *most probably* follow the entrance of the moon into any of its quarters—so probably, indeed, that it has seldom been found to fail.

TABLE, *for telling the weather through all the lunations of each year forever.*

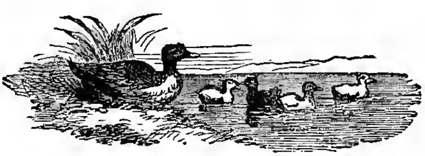
MOON	TIME OF CHANGE.	IN SUMMER.	IN WINTER.
If the new moon, the 1st quarter, full moon, or last quar., happens	Between midnight and two in the morning,	Fair.	Hard frost, unless the wind be S. or W.
	—— 2 and 4, morning,	Cold, with frequent showers.	Snow and stormy.
	—— 4 and 6 "	Rain.	Rain.
	—— 6 and 8 "	Wind and rain.	Stormy.
	—— 8 and 10 "	Changeable.	Cold rain, if wind be W.; snow if E.
	—— 10 and 12 "	Frequent showers.	Cold and high wind.
	At 12 o'clock at noon, and 2, P. M.	Very rainy.	Snow or rain.
	Between 2 and 4, P. M.	Changeable.	Fair and mild.
	—— 4 and 6, "	Fair.	Fair.
	—— 6 and 8, "	Fair, if wind N. W. Rainy, if S. or S. W.	Fair and frosty, if wind N. or N. E. Rain or snow, if S. or S. W.
	—— 8 and 10, "	Do.	Do.
	—— 10 and midnight,	Fair.	Fair and frosty.

OBSERVATIONS.—1. The nearer the time of the moon's change, first quarter, full, or last quarter are to *midnight*, the fairer will the weather be during the seven days following.

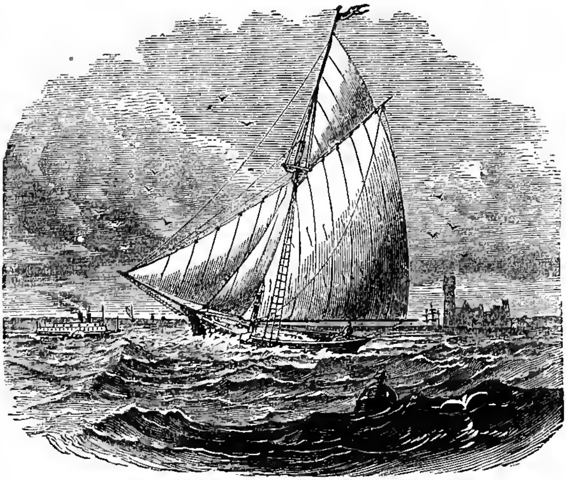
2. The space for this calculation occupies from ten at night till two next morning.

3. The nearer to *mid-day* or *noon*, the phases of the moon happen, the more foul or wet weather may be expected during the next seven days.

4. The space of this calculation occupies from ten in the forenoon to two in the afternoon. These observations refer principally to the summer, though they affect spring and autumn nearly in the same ratio.



WIND.



The force of the wind increases directly as the square of the velocity. Thus, a wind blowing 10 miles an hour exerts a pressure four times as great as at 5 miles an hour, and 25 times as great as at 2 miles an hour.

To find the force of wind acting directly against a surface.

RULE.—Multiply the surface in square feet by the lbs. pressure per square foot as given in the following table.

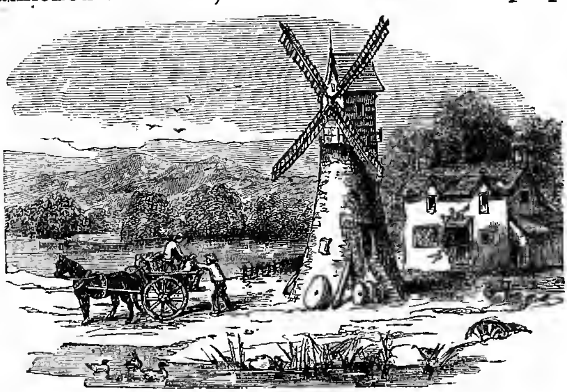
EXAMPLE.—What is the pressure of a wind of a velocity of 20 miles per hour against a barn door 10 feet by 6?

SOLUTION.—$10 \times 6 = 60$ sq. ft., surface, $\times 2$ lbs., pressure per square foot, $= 120$ lbs. *Ans.*

TABLE, *showing the force and velocity of wind.*

Miles per hour.	Feet per minute.	Lbs pressure on 1 sq. foot.	Description.
1	88	.005	Barely observable.
2	176	.020	Just perceptible.
3	264	.045	
4	352	.080	Light breeze.
5	440	.125	Gentle, pleasant wind.
6	528	.180	
8	704	.320	
10	880	.500	Brisk blow.
15	1320	1.125	
20	1760	2.000	Very brisk.
25	2200	3.125	
30	2640	4.500	High wind.
35	3080	6.125	
40	3520	8.000	Very high.
45	3960	10.125	
50	4400	12.500	Storm.
60	5280	18.000	Great storm.
80	7040	32.000	Hurricane.
100	8800	50.000	Tornado, uprooting trees, sweeping off buildings, &c.

The mechanical force of wind is well illustrated in the old-fashioned windmills, which were used for the purpose of



Windmill.

raising water and grinding grain, where facilities for steam or water-power were wanting.

AVERAGE TEMPERATURE AND FALL OF RAIN.

TABLE, *showing the average temperature of the four Seasons at points on the Pacific and Atlantic coasts, and the interior of this continent.*

		TEMPERATURE.				
	Latitude.	Spring.	Summer	Autumn	Winter.	Year.
PACIFIC COAST.						
Monterey,	36°36′	53°·99	58°·64	57°·29	51° 22	55°·29
San Francisco	37°48′	54°·41	57°·33	56° 83	50°·86	54°·88
Astoria	46°11′	51°·16	61°·58	53°·76	42°·43	52°·23
INTERIOR.						
St. Louis Arsenal,	38°40′	54°·15	76°·19	55°·44	32°·27	54°·51
Chicago,	41°52′	44° 90	67°·33	48°·85	25°·90	46°·75
Fort Ripley	46°19′	39°·33	64° 94	42°·91	10°·01	39°·30
ATLANTIC COAST.						
Fort Monroe, near Norfolk,	37°	56°·87	76°·57	61°·68	40°·45	58°·89
Fort Columbus, N. Y. Harbor,	40°42′	48°·74	72°·10	54° 55	31°·38	51°·69
Fort Sullivan. Eastport,	44°15′	40°·15	60°·50	47°·52	23° 90	43°·02

From this table it will be perceived that Astoria, on the Pacific coast, and Fort Ripley in the interior, are in about the same latitude. Astoria, though 650 miles north of Monterey, is only 3 degrees colder. Fort Ripley is *fifteen* degrees colder than St. Louis, although it is only about 500 miles further north.

San Francisco, St. Louis, and Fort Monroe, are in about the same latitude. The difference between the mean summer and winter temperature of San Francisco is less than *seven* degrees; of St. Louis, nearly *forty-four* degrees; and of Fort Monroe, *thirty-six* degrees. Eastport is two degrees south of Astoria, but is *nine* degrees colder.

The United States may be divided with reference to the fall of rain into three regions, namely: the region of periodical rains, the region of frequent rains, and the region of scanty rains.

The region of periodical rains comprises the western division of the Pacific slope.

In that portion of this division south of the 40th parallel of latitude, scarcely any rain falls in summer, and very little in autumn. The quantity in winter somewhat exceeds that which falls during the spring.

A much greater quantity of rain falls upon that part of the division north of lat. 40° than south of it; but, as in the southern division, the largest amount belongs to the winter and spring.

The region of frequent rains extends from the Atlantic coast westward to about the 100th meridian of longitude. This region, considered as a whole, is exceedingly well watered, the rain being quite equally distributed through the different seasons.

From an examination of the table, it will appear that along the Atlantic slope, as far south as Washington, very nearly the same annual quantity of rain falls; and that it is very equally distributed throughout the year. In the Gulf States, and along the Atlantic slope south of Washington, the annual amount of rain is much greater than in the other sections, and the summer rains are much more abundant than those of the winter. In the interior the annual quantity is less, and generally much less rain falls in winter than in the other seasons.

The region of scanty rains embraces the country between about the 100th meridian of longitude and the Cascade and Sierra Nevada Mountains. It includes the northern and southern divisions of the Pacific slope, the inland basin of Utah, the table-lands of the Texas slope, and the sterile region east of the Rocky Mountains.

Among the mountains of this region a considerable quantity of rain falls, and violent showers are experienced in all seasons of the year. Some of the mountain valleys are also well watered. Thus the annual fall of rain at Santa Fe, situated on a plateau enclosed by mountains, is 19.83 inches; and the fall at Fort Massachusetts, which is situated in a valley 100 miles further north, is 20.54 inches.

The annual fall of rain in the desert region, through which the great Colorado flows, is estimated at three inches; that of the inland basin of Utah, at five inches; of the Great Plain south of the Columbia River, ten inches; of the Llano Estacado, ten inches; and of the sterile region east of the Rocky Mountains, from fifteen to twenty inches. In all these sections scarcely any rain falls in summer.

The greatest amount of rain reported in the "Army Meteorological Register," for any given year, was the fall, in 1846, at Baton Rouge, of 116.6 inches; the least, a fall, in 1853, at Fort Yuma, California, of 1.78 inches.

[This valuable Table is compiled from the "Army Meteorological Register," and presents the results of all the records, in the Army Medical Bureau, for 33 years, from 1822 to the close of 1854.]

TABLE, *showing the latitude and longitude, the elevation above the level of the sea, the mean annual temperature, and the average annual fall of rain at various places in the United States.*

NAME OF PLACE OF OBSERVATION	Latitude.	Longitude West from Greenwich.	Elevation above the level of the sea in feet.	Mean Annual temperature.	Average annual fall of rain in inches.
Fort Kent, Maine	47°15′	68°35′	575	37°·04	36·46
Fort Fairfield, Maine	46 46	67 49	415	38·11	
Hancock Barracks, Maine	46 07	67 49	620	40·51	36·97
Fort Sullivan, Eastport, Maine	44 54	66 58	70	43·02	39·39
Fort Preble, Portland, Maine	43 39	70 20	20	45·22	45·25
Fort Constitution, Portsmouth, N.H	43 04	70 49	40	45·81	35·57
Fort Independence, Bost. Har, Mass	42 20	71	50	48·92	35·30
Watertown Arsenal, Mass	41 21	71 09		47·34	42·07
Fort Adams, Rhode Island	41 29	71 20	40	49·70	52·46
Fort Wolcott, Newport Harbor, R. I.	41 30	71 20	20	50·72	
Fort Trumbull, New London, Conn.	41 21	72 06	23	49·62	45·69
Fort Columbus, N. Y. Harbor	40 42	74 01	23	51·69	42·23
Fort Hamilton, N. Y. Harbor	40 37	74 02	25	51·54	43·65
West Point, New York	41 23	74	167	50·73	54·15
Watervliet Arsenal, New York	42 43	73 43	50?	48·07	34·55
Plattsburg Barracks, New York	44 41	73 25	186	44.	33·39
Sackett's Harbor, New York	43 57	76 15	262	46·38	39·78
Fort Ontario, New York	43 20	76 40	250	46·44	30·88
Fort Niagara, New York	43 18	79 08	250	47.91	31·77
Buffalo Barracks New York	42 53	78 58	660	46.25	38·80
Alleghany Arsenal, Pittsburg, Pa.	40 32	80 02	704	50.86	34·96
Carlisle Barracks Carlisle, Pa	40 12	77 14	500	51·10	34·01
Fort Mifflin, Pa	39 53	75 13	20	53·85	45·27
Fort Delaware, Del	39 35	75 34	10	56·06	
Fort McHenry, Md	39 17	71 35	36	54·36	42·
Fort Severn, Md	38 58	76 27	20	55·42	48·61
Washington City, D. C	38 53	77 02	50–90	56·14	41·20
Fort Washington, Md	38 43	77 06	60	57·87	45·02
Bellona Arsenal, Richmoud, Va	37 20	77 25	120	59·27	
Fort Monroe Va	37	76 18	8	58·89	50.89
Fort Macon, N C	34 41	76 40	20	62·23	
Fort Johnston, N. C	34	78 05	20	65·68	46.01
Augusta Arsenal Ga	33 28	81 53	600?	64·01	23·
Fort Moultrie, Charleston, S C	32 45	79 51	25	66·58	44·92
Oglethorpe Barracks Ga	32 05	81 07	40	67·44	53·33
Fort Marion, St Augustine, Fla	29 38	81 35	25	69·61	31·80
Fort Shannon, Pilatka, East Fla	29 34	81 48	25	69·64	48·68
New Smyrna, East Fla	28 54	81 02	20	69·17	

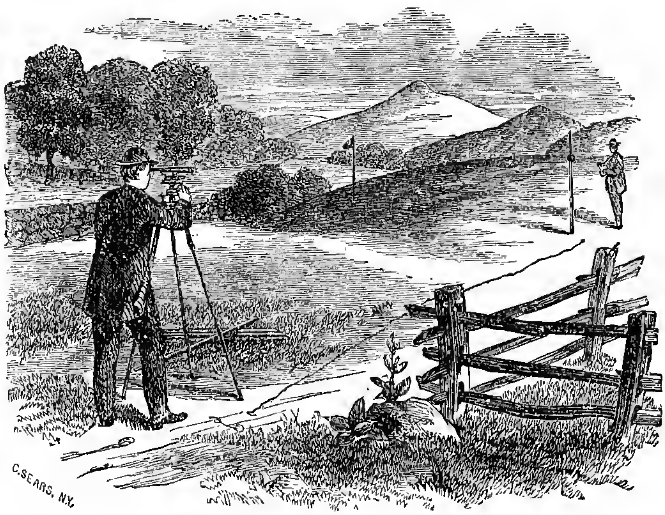
Table continued.

NAME OF PLACE OF OBSERVATION	Latitude.	Longitude West from Greenwich.	Elevation above the level of the sea, in feet.	Mean Annual temperature.	Average Annual fall of rain in inches.
Fort Pierce, East Fla.	27°30′	80°20′	30	73°·20	62·98
Fort Dallas, East Fla.	25 55	80 20	20	74·75	
Key West, Fla.	24 32	81 48	10	76·51	47·65
Fort Myers, South Fla.	26 38	82 02	50	75·04	62·26
Fort Brooke, Tampa Bay, Fla.	28	82 28	20	71·92	55·47
Fort Meade, Fla.	28 01	82	80	71·48	40·22
Fort Micanopy, Fla.	29 30	82 28	60?	70·09	
Fort King, Fla.	29 10	82 10	50	70·	
Cedar Keys, Fla.	29 07	83 03	35	69·60	48 50
Fort Fanning, Fla.	29 35	83	50	70·20	
Fort Barrancas, Pensacola, Fla.	30 18	87 27	20	68·74	56·98
Fort Morgan, Ala.	30 14	88	20	66·88	
Mt. Vernon Arsenal, Ala.	31 12	88 02	200?	65·84	63·50
Fort Pike, La.	30 10	89 38	10	69·86	71·92
Fort Wood, La.	30 08	89 51	20	69·25	60·65
New Orleans, La.	29 57	90	10	69·86	50 90
Baton Rouge, La.	30 26	91 78	41	68·14	62·10
Fort Jessup, La.	31 33	93 32	80?	66·34	45·85
Fort Towson, Ind. Ter.	34	95 33	300?	61·69	51·08
Fort Washita, Indian Ter.	24 14	96 38	645	62·21	41·66
Fort Smith, Arkansas	35 23	94 29	460	60·02	42 10
Fort Gibson, Ind. Ter.	34 47	95 10	560	60·81	36·46
Fort Scott, Mo.	37 45	94 35	1000?	54·50	42·12
Jefferson Barracks, Mo.	38 28	90 15	472	55·46	37·83
St. Louis Arsenal, Mo.	38 40	90 05	450	54·51	41·95
Newport Barracks, Newport, Ky.	39 05	84 29	500	55·26	
Detroit, Mich.	42 20	82 58	580	47·25	30·07
Fort Gratiot, Mich.	42 55	82 23	598	46·29	32·62
Fort Mackinac, Mich.	45 51	84 32	728	40·65	23·87
Fort Dearborn, Chicago, Ill.	41 52	87 35	591	46·75	
Fort Brady, Mich.	46 30	84 43	600	40·37	31·35
Fort Wilkins, Mich.	47 30	88	620	41·	
Fort Howard, Wis.	44 30	88 05	620	44·49	34·65
Fort Winnebago, Wis.	43 31	89 28	770?	44·80	27·49
Fort Crawford, Wis.	43 05	91	642	47·63	31·40
Fort Armstrong, Ill.	41 30	90 40	528	50·31	
Fort Atkinson, Iowa	43	92	700?	45·50	39·74
Fort Des Moines, Iowa	41 32	93 38	780	49·74	26·56
Fort Ripley, Minnesota	46 19	94 19	1130	39·30	29·48
Fort Snelling, Minn.	44 53	93 10	820	44·54	25·43
Fort Leavenworth, Kansas	39 21	94 44	896	52·78	30·29
Council Bluffs, Nebraska	41 30	95 48	1250	49·28	
Fort Kearney, Nebraska	40 38	98 57	2360	47·67	27.98
Fort Laramie, Nebraska	42 12	104 47	4519	50·06	19·98
Fort Arbuckle Ind Ter.	34 27	97 09	1000?	60·83	30·57
Fort Belknap, Texas	33 08	98 48	1600?	63·99	22·

Table continued.

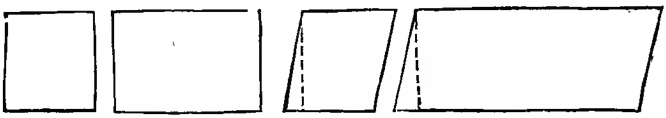
NAME OF PLACE OF OBSERVATION.	Latitude.	Longitude West from Greenwich.	Elevation above the level of the sea. In feet.	Mean Annual temperature.	Average Annual fall of rain in inches.
Fort Worth, Texas	32°40′	97°25′	1100 ?	63° 54	40·86
Phantom Hill, Texas	32 30	99 45	2300 ?	63·73	17·22
Fort Chadbourne, Texas	31 38	100 40	2120	62·38	31·88
Fort Graham. Texas	31 56	97 26	900 ?	65·76	40·58
Fort Gates, Texas	31 26	97 49	1000 ?	66·12	
Fort Croghan, Texas	30 40	98 31	1000 ?	65·74	36·56
San Antonio. Texas	29 25	98 25	600	69·25	33·77
Fort Merrill, Texas	28 17	98	150 ?	71·37	
Fort Ewell, Texas	28 05	98 57	200	71·30	
Corpus Christi. Texas	27 47	97 27	20	70·95	30·82
Fort Brown, Texas	25 54	97 26	50	73·75	33·65
Ringgold Barracks, Texas	26 23	99 02	200 ?	74·21	20·95
Fort McIntosh, Texas	27 31	99 21	400	73·24	18·66
Fort Duncan, Eagle Pass, Texas	28 42	100 30	800	70·85	22·20
Fort Inge, Texas	29 09	99 07	845	67·69	27·99
Fort Lincoln. Texas	29 22	99 33	900 ?	68·03	20·58
Fort Clark, Texas	29 17	100 25	1000 ?	61·04	21·80
Fort Fillmore, New Mexico	32 13	106 42	3937	63·98	9·28
Fort Webster, New Mexico	32 48	108 04	6350	54·84	8·79
Fort Conrad, New Mexico	33 34	107 09	4576	59·40	6·76
Albuquerque, New Mexico	35 06	106 38	5032	56·32	9·42
Cebolleta and Laguna, New Mexico	35 03	107 14	6000	55·12	12·05
Santa Fé, New Mexico	35 41	106 02	6846	50·59	19·83
Las Vegas, New Mexico	35 35	105 16	6418	49·14	19·24
Fort Union, New Mexico	35 54	104 57	6670	49·14	19·24
Fort Massachusetts, New Mexico	37 32	105 23	8365	49·11	20·54
Fort Defiance. New Mexico	35 44	109 15	7200 ?	46·92	16·64
Fort Yuma, California	32 43	114 36	120	73·62	3·24
San Diego, California	32 42	117 14	150	62·	10·43
Posts Del Chino and Jurupa, Cal'a.	34	117 25	1000 ?	63·28	13·77
Monterey. California	36 36	121 52	140	55·29	12·20
Fort Miller, California	37	119 40	402	66·	24·51
San Francisco. California	37 48	122 26	150	54·88	23·59
Benicia Barracks, California	38 03	122 08	64	58·29	16·62
Sacramento, California	38 33	121 20	50	59·89	21·32
Fort Reading, California	40 30	122 05	674	62·09	29·02
Fort Humboldt, California	40 46	124 09	50	52·80	16·77
Fort Jones. California	41 36	122 52	2570	51·40	16·77
Fort Orford, California	42 44	124 29	50	53·62	68.52
Fort Vancouver. Oregon	45 40	122 30	50	52·65	45·50
Fort Dalles, Oregon	45 36	120 55	350	52·79	14.32
Fort Steilacoom, Washington Ter.	47 10	122 25	300 ?	50·82	51 75
Astoria. Oregon	40 11	123 48	50	52 23	
Great Salt Lake, Utah	40 46	112 06	4351	53·24	

MEASUREMENT OF LAND.



Every farmer should know the contents, in acres, of each of his fields, meadows, and lots, to ascertain which he should have a rod measure, a light stiff pole, just $16\frac{1}{2}$ feet long, with division marks on it of a yard each, making $5\frac{1}{2}$ yards. Provided with this measure, and proceeding according to the following rules, he can ascertain the area in acres of each of his fields, lots, &c.

Where the field is a square, a parallelogram, a rhombus, or a rhomboid.



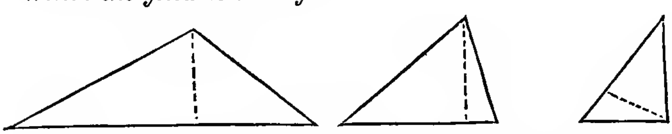
Square. Parallelogram. Rhombus. Rhomboid.

RULE.—Multiply the length in rods by the breadth in rods, and divide the product by 160, and the quotient will be the number of acres.

EXAMPLE.—What is the area in acres of a field of 30 rods long by 28 rods wide.

SOLUTION.—$30 \times 28 = 840 \div 160 = 5$ acres and 40 rods, or $5\frac{1}{4}$ acres. *Ans.*

Where the field is triangular.

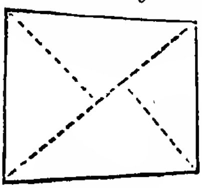


RULE.—Multiply the base or longest side, in rods, by the perpendicular height (*i.e.*, the greatest width), in rods, and divide half the product by 160, and the quotient will be the number of acres.

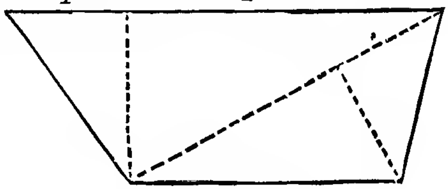
EXAMPLE.—What is the area in acres of a triangular field, the base of which is 60 rods long, and its perpendicular height 28 rods?

SOLUTION.—$60 \times 28 = 1680 \div 2 = 840 \div 160 = 5$ acres and 40 rods, or $5\frac{1}{4}$ acres. *Ans.*

When the field is a trapezium or a trapezoid.



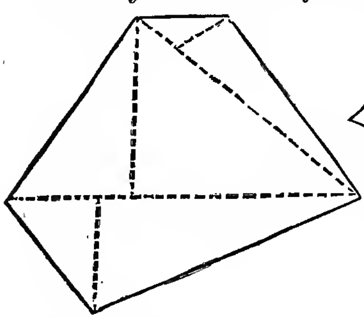
Trapezium.

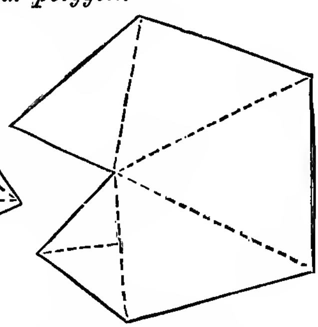


Trapezoid.

RULE.—Divide it diagonally by a line running from one extreme corner to the other, which will cut the field into two triangles; then proceed with each as in the foregoing rule, and add the areas of the two triangles together. The product will be the number of acres.

Where the field is an irregular polygon.

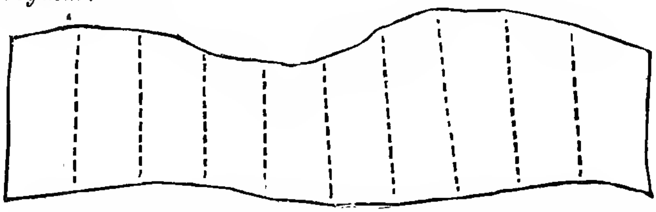




RULE.—Draw diagonals to divide the field into triangles; find the area of each separately, and the sum of the whole will be the number of acres.

NOTE.—There are very few fields or lots which cannot be measured by cutting them into triangles, and proceeding by the above rule. In fact, all straight-sided fields can be so measured.

Where the field is long, and the sides crooked and irregular.

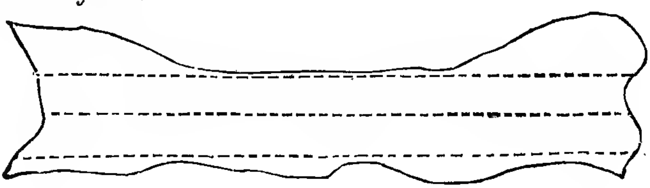


Rule.—Take the breadth in rods in a number of places, at equal distances apart; add them, and divide the sum by the number of breadths for the mean average or breadth; then multiply that by the length in rods and divide the product by 160, and the quotient will be the number of acres.

Example.—What is the area in acres of a long irregular-sided field, the length of which is 80 rods, and its breadths at 10 rods apart are as follows, viz.: 8, 10, 11, 9, 8, 7, 9, 10 rods?

Solution.—$8+10+11+9+8+7+9+10 = 72 \div 8 = 9$ rods mean breadth; then $9 \times 80 = 720 \div 160 = 4$ acres and 80 rods, or $4\frac{1}{2}$ acres. *Ans.*

Where the field is long, and the sides and ends crooked and irregular.



RULE.—Find the mean breadth in rods by the foregoing rule, and proceed in like manner to find the mean length in rods; then multiply the mean length by the mean breadth, and divide the product by 160, and the quotient will be the number of acres.

EXAMPLE.—What is the area in acres of a field of irregular sides and ends, the various breadths of which are as follows, viz.: 9, 6, 7, 8, 10 and 8 rods, and the lengths as follows, viz.: 50, 40, 30 and 40 rods?

SOLUTION.—$9+6+7+8+10+8=48 \div 6=8$ rods mean breadth.

$50+40+30+40=160 \div 4=40$ rods mean length.

Then $40 \times 8=320 \div 160=2$ acres. *Ans.*

Where the field is a circle.

RULE.—Take the diameter in rods, and find the area of the circle in the table of circles on page 298, and divide it by 160, and the quotient will be the number of acres.

EXAMPLE.—What is the area in acres of a circular field 22 rods in diameter?

SOLUTION.—380, area of circle, $\div 160=2$ acres and 80 rods, or $2\frac{1}{2}$ acres. *Ans.*

An acre of land is contained in a plot,

3 by $53\frac{1}{3}$ rods	7 by $22\frac{6}{7}$ rods	10 by 16 rods
4 by 40 "	8 by 20 "	11 by $14\frac{6}{11}$ "
5 by 32 "	9 by $17\frac{7}{9}$ "	12 by $13\frac{1}{3}$ "
6 by $26\frac{2}{3}$ "		

12 rods 10 feet and $8\frac{1}{2}$ inches square make an acre.

It is often desirable, for experimental and other purposes, for a farmer to lay off small portions of his ground. To enable him to do so, we have compiled the following:

Table, *showing the square feet and the feet square of the fractions of an acre.*

Fractions of an acre.	Square feet.	Feet square.	Fractions of an acre.	Square feet.	Feet square.
1/16	2722½	52½	½	21780	147½
⅛	5445	73¾	1	43560	208¼
¼	10890	104½	2	87120	295¼
⅓	14520	120½			

Table, *showing the number of hills or plants on an acre of land, for any distance apart, from* 10 *inches to* 6 *feet—the lateral and longitudinal distances being unequal.*

	10 in.	12 in.	15 in.	18 in.	20 in.	2 ft.	2½ ft.	3 ft.	3½ ft.	4 ft.	4½ ft.	5 ft.	5½ ft.	6 ft.
10 in.	62726													
12 "	52272	43560												
15 "	41817	34848	27878											
18 "	34848	29040	23232	19360										
20 "	31363	26136	20908	17424	15681									
2 feet	26136	21780	17424	14520	13068	10890								
2½ "	20908	17424	13939	11616	10454	8712	6969							
3 "	17424	14520	11616	9680	8712	7260	5808	4840						
3½ "	14935	12446	9953	8297	7467	6223	4976	4148	3565					
4 "	13068	10890	8712	7260	6534	5445	4356	3630	3111	2722				
4½ "	11616	9680	7744	6453	5808	4840	3872	3226	2767	2420	2151			
5 "	10454	8712	6969	5808	5227	4356	3484	2904	2489	2178	1936	1742		
5½ "	9504	7920	6336	5280	4752	3960	3168	2640	2263	1980	1760	1584	1440	
6 "	8712	7260	5808	4840	4356	3630	2904	2420	2074	1865	1613	1452	1320	1210

Explanation.—Find the distance between your plants or hills the widest way in the left hand column, then trace the line in which it stands to the right, until it intersects the column headed by the number that expresses the distance of the narrow way, where you will find the number sought.

EXAMPLE.—The rows of corn in a corn-field are 5½ feet apart, and the plants 20 inches apart, in drill or hill; required, the number of hills or plants in an acre?

SOLUTION.—Find 5½ feet (the distance of the rows apart), in the left hand column, then trace the line along unto the column headed by 20 inches (the distance of the plants or hills apart), and you have 4752. *Ans.*

TABLE, *showing the number of plants, hills, or trees contained in an acre at equal distances apart, from* 3 *inches up to* 66 *feet.*

Distance apart.	No. of plants.	Distance apart.	No. of plants.
3 inches by 3 inches	696,960	6 feet by 6 feet	1,210
4 " by 4 "	392,040	6½ " by 6½ "	1,031
6 " by 6 "	174,240	7 " by 7 "	881
9 " by 9 "	77,440	8 " by 8 "	680
1 foot by 1 foot	43,560	9 " by 9 "	537
1½ feet by 1½ feet	19,360	10 " by 10 "	435
2 " by 1 foot	21,780	11 " by 11 "	360
2 " by 2 feet	10,890	12 " by 12 "	302
2½ " by 2½ "	6,960	13 " by 13 "	257
3 " by 1 foot	14,520	14 " by 14 "	222
3 " by 2 feet	7,260	15 " by 15 "	193
3 " by 3 "	4,840	16 " by 16 "	170
3½ " by 3½ "	3,555	16½ " by 16½ "	160
4 " by 1 foot	10,890	17 " by 17 "	150
4 " by 2 feet	5,445	18 " by 18 "	134
4 " by 3 "	3,630	19 " by 19 "	120
4 " by 4 "	2,722	20 " by 20 "	108
4½ " by 4½ "	2,151	25 " by 25 "	69
5 " by 1 foot	8,712	30 " by 30 "	48
5 " by 2 feet	4,356	33 " by 33 "	40
5 " by 3 "	2,904	40 " by 40 "	27
5 " by 4 "	2,178	50 " by 50 "	17
5 " by 5 "	1,742	60 " by 60 "	12
5½ " by 5½ "	1,417	66 " by 66 "	10

GOVERNMENT LAND MEASURE.

A township is 6 miles square, and contains 36 sections, or 23,040 acres.

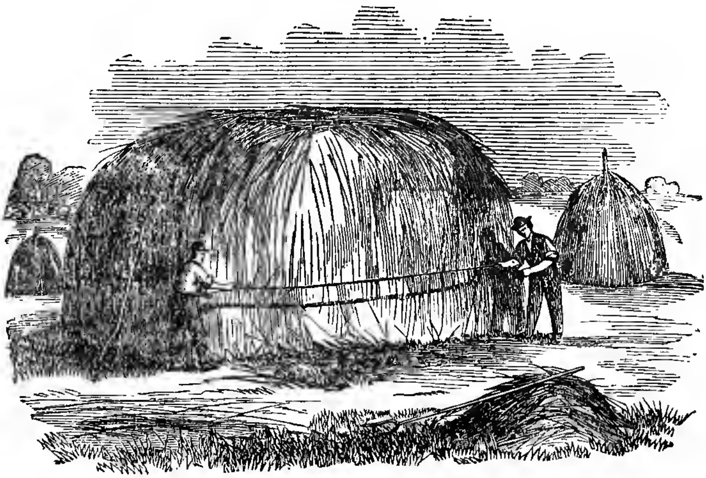
A section is 1 mile square, and contains 640 acres.

A quarter-section is half a mile square, and contains 160 acres.

A half quarter-section is half a mile long, almost universally north and south, and one-fourth of a mile wide, and contains 80 acres.

A quarter quarter-section is one-fourth of a mile square, and contains 40 acres. It is the smallest sized tract, except fractions, sold by the government.

MEASUREMENT OF HAY.



There is no accurate mode of measuring hay but by weighing it. This, on account of its bulk and character, is very difficult, unless it is baled or otherwise compacted. This difficulty has led farmers to estimate the weight by the bulk or cubic contents, a mode which, from the nature of the commodity, is only approximately correct. Some kinds of hay are light, while others are heavy, their equal bulks varying in weight. But for all ordinary farming purposes of estimating the amount of hay in meadows, mows, and stacks, the following rules will be found sufficient.

As nearly as can be ascertained, 25 cubic yards of average meadow hay, in windrows, make a ton.

When well settled in mows or stacks, 15 or 18 cubic yards make a ton.

When taken out of mows or old stacks, and loaded on wagons, 20 or 25 cubic yards make a ton.

Twenty or twenty-five cubic yards of clover, when dry, make a ton.

To find the number of tons of meadow hay raked into windrows.

RULE.—Multiply the length of the windrow in yards by the width in yards, and that product by the height in yards, and divide by 25; the quotient will be the number of tons in the windrow.

EXAMPLE.—How many tons of hay in a windrow 40 yards long by 2 wide and 2 high?

SOLUTION.—$40 \times 2 \times 2 = 160 \div 25 = 6\frac{2}{5}$. *Ans.*

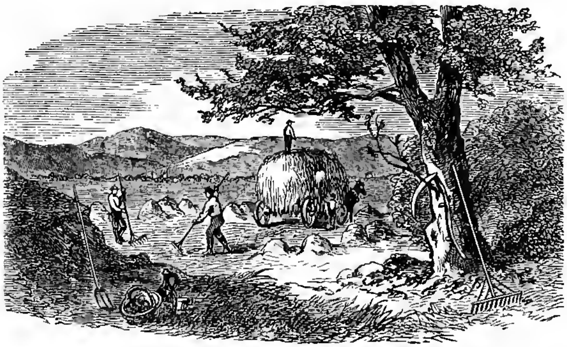
To find the number of tons of hay in a mow.

RULE.—Multiply the length in yards by the height in yards, and that by the width in yards, and divide the product by 15; the quotient will be the number of tons.

EXAMPLE.—How many tons of well-settled hay in a mow 10 yards long by 6 wide and 8 high?

SOLUTION.—$10 \times 6 \times 8 = 480 \div 15 = 32$ tons. *Ans.*

To find the number of tons of hay in old stacks.



Rule.—Find the area in square yards of the base in the table of the areas of circles on page 298, or by the rule given on page 296; then multiply the area of the base by half the altitude of the stack in yards, and divide the product by 15; the quotient will be the number of tons.

Example.—How many tons of hay in a circular stack, whose diameter at the base is 8 yards, and height 9 yards?

Solution.—50.265, area of base in sq. yards, $\times 4\frac{1}{2}$, half the altitude, $=226.192 \div 15 = 15.079$ tons. *Ans.*

To find the number of tons in long square stacks.

Rule.—Multiply the length in yards by the width in yards, and that by half the altitude in yards, and divide the product by 15; the quotient will be the number of tons.

Example.—How many tons of hay in a square stack 10 yards long, 5 wide, and 9 high?

Solution.—$10 \times 5 \times 4\frac{1}{2} = 225 \div 15 = 15$ tons. *Ans.*

To find the number of tons of hay when taken out of mows or old stacks.

RULE.—Multiply the length of the load in yards by the width in yards, and that by the height in yards, and divide the product by 20; the quotient will be the number of tons.

EXAMPLE.—How many tons of hay taken from an old stack, in a load 6 yards long by 3 wide and 3 high?

SOLUTION.—$6 \times 3 \times 3 = 54 \div 20 = 2\frac{7}{10}$ tons. *Ans.*

These estimates are for medium sized mows or stacks. If the hay is piled to a great height, as it often is where horse hay-forks are used, the row will be much heavier per cubic yard.

TABLE, *showing the price per cwt. of hay, at given prices per ton.*

Price per ton.	½ hundred.	1 hundred.	2 hundred.	3 hundred.	4 hundred.	5 hundred.	6 hundred.	7 hundred.	8 hundred.	9 hundred.	10 hundred.	11 hundred.
$	cts.	cts	$ cts	$ cts	$ cts	$ cts	$ cts	$ cts	$ cts	$ cts	$ cts	$ cts
4	10	20	40	60	80	1.00	1.20	1.40	1.60	1.80	2.00	2.20
5	12	25	50	75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75
6	15	30	60	90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.30
7	17	35	70	1.05	1.40	1.75	2.10	2.45	2.80	3.15	3.50	3.85
8	20	40	80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00	4.40
9	22	45	90	1.35	1.80	2.25	2.70	3.15	3.60	4.05	4.50	4.95
10	25	50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50
11	27	55	1.10	1.65	2.20	2.75	3.30	3.85	4.40	4.95	5.50	6.00
12	30	60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00	6:60
13	32	65	1 30	1.95	2.60	3.25	8.90	4.55	5.20	5.85	6.50	7.15
14	35	70	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00	7.70
15	37	75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50	8.25

Table continued.

Price per ton.	12 hundred.	13 hundred.	14 hundred.	15 hundred.	16 hundred.	17 hundred.	18 hundred.	19 hundred.	20 hundred.
$	$ *cts*	$ *cts*	$ *cts*	$ *cts*	$ *cts*	$ *cts*	$ *cts*	$ *cts*	$ *cts*
4	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00
5	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
6	3.60	3 90	4.20	4.50	4.80	5.10	5.40	5.70	6.00
7	4.20	4.55	4.90	5.25	5.60	5.95	6.30	6.65	7.00
8	4.80	5.20	5.60	6.00	6.40	6.80	7.20	7.60	8.00
9	5.40	5.85	6.30	6.75	7.20	7.65	8.10	8.55	9.00
10	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00
11	6.60	7.15	7.70	8.25	8.80	9.35	9.90	10.45	11.00
12	7.20	7.80	8.40	9.00	9.60	10.20	10.80	11.40	12.00
13	7.80	8.45	9.10	9.75	10.40	11.05	11.70	12.35	13.00
14	8.40	9.10	9.80	10.50	11.20	11.90	12.60	13.30	14.00
15	9.00	9.75	10.50	11.25	12.00	12.75	13.50	14.25	15.00

An easy mode of ascertaining the value of a given number of lbs. of hay, at a given price per ton of 2000 lbs.

RULE.—Multiply the number of pounds of hay (coal, or anything else which is bought and sold by the ton) by one half the price per ton, pointing off three figures from the right hand; the remaining figures will be the price of the hay (or any article by the ton).

EXAMPLE.—What will be the cost of 658 lbs. of hay, at $7.50 per ton?

SOLUTION.—$7.50 divided by 2 equals $3.75, by which multiply the number of pounds, thus:

```
    658
  $3.75
  -----
   3290
  4606
 1974
  -----
$2.46||750.   Ans.
```

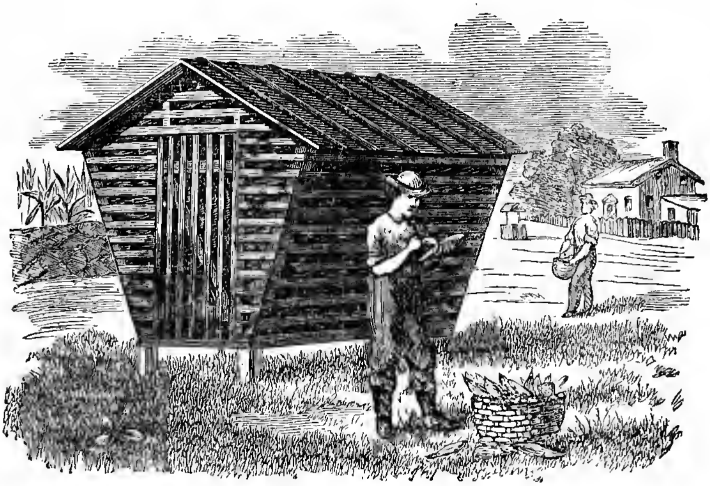
Note.—The principle in this rule is the same as in interest—dividing the price by two gives us the price of half a ton, or 1000 lbs.; and pointing off three figures to the right is dividing by 1000.

A *truss* of hay, new, is 60 lbs.; old, 56 lbs.; straw, 40 lbs.

A *load* of hay is 36 trusses.

A *bale* of hay is 300 lbs.

TO MEASURE CORN ON THE COB IN CRIBS.



When the crib is equilateral.

RULE.—Multiply the length in inches by the breadth in inches, and that again by the height in inches, and divide the product by 2748 (the number of cubic inches in a heaped bushel), and the quotient will be the number of heaped bushels of ears. Take two-thirds of the quotient for the number of bushels of shelled corn.

EXAMPLE.—Required the number of bushels of shelled corn contained in a crib of ears, 15 feet long by 5 feet wide and 10 feet high?

SOLUTION.—180 in., length, ×60 in., width, ×120 in., height, $=1296000 \div 2748 = 471.6$ heaped bushels, $\frac{2}{3}$ of which is 314.6 bushels shelled. *Ans.*

NOTE.—The above rule assumes that three heaping half bushels of ears make one struck bushel of shelled corn. This proportion has been adopted upon the authority of the major part of our best agricultural journals. Nevertheless, some journals claim that two heaping bushels of ears to one of shelled corn is a more correct proportion, and it is the custom in many parts of the country to buy and sell at that rate. Of course, much will depend upon the kind of corn, the shape of the ear, the size of the cob, &c. Some samples are to be found, three heaping half bushels of which will even overrun one bushel shelled; while others again are to be found, two bushels of which will fall short of one bushel shelled. Every farmer must judge for himself, from the sample on hand, whether to allow one and a half or two bushels ears to one of shelled corn. In either case, it is only an approximate measurement, but sufficient for all ordinary purposes of estimation. The only true way of measuring all such products is by weight.

When the crib is flared at the sides.

RULE.—Multiply half the sum of the top and bottom widths in inches by the perpendicular height in inches, and that again by the length in inches, and divide the product by 2748, and the quotient will be the number of heaped bushels of ears. Take two-thirds of the quotient for the number of bushels of shelled corn.

Example.—Required, the number of bushels of shelled corn contained in a crib of ears 4 feet wide at the bottom, 8 feet at the top, 10 feet in perpendicular height, and 15 feet long?

Solution.—48 inches, bottom width, +96 inches, top width, $=144 \div 2 = 72 \times 120$ inches perpendicular height, $\times$ 180 inches length, $=1555200 \div 2748 = 565.9$ bus. ears, $\frac{2}{3}$ of which is 377.28 bus. shelled corn. *Ans.*

Note.—A barrel of corn is 5 bushels shelled. By this latter measure crops are estimated, and corn bought and sold throughout most of the Southern and Western States. At New Orleans a barrel of corn is a flour-barrel full of ears. In some parts of the West, it is common to count 100 ears to the bushel.

MEASUREMENT OF GRAIN IN GRANARIES.

To find the number of bushels of grain in a granary.

Rule.—Multiply the length in inches by the breadth in inches, and that again by the depth in inches, and divide the product by 2150 (the number of cubic inches in a bushel), and for heaped bushels by 2748, and the quotient will be the answer.

Example.—Given a granary 9 feet long by 4 wide and 6 deep. How many bushels will it contain?

Solution.—108 inches length, ×48 inches width, ×72 in. depth,=373248÷2150=173.65 bus. *Ans.*

MEASUREMENT OF TIMBER.

The unit of board measure is a superficial foot 1 inch thick.

Besides inch-boards, plank and scantling are usually bought and sold by board measure.

Round, sawed, or hewn timber is bought and sold by the cubic foot.

Pine and spruce spars, from 10 to $4\frac{1}{2}$ inches in diameter inclusive, are measured by taking the diameter, clear of bark, at one-third of their length from the large end.

Spars are usually purchased by the inch diameter; all under 4 inches are considered *poles.*

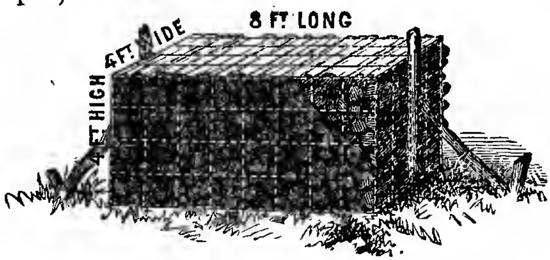
Spruce spars of 7 inches and less, should have 5 feet in length for every inch in diameter.

WOOD MEASURE.

To ascertain the contents or number of cords in a given pile of wood.

RULE.—Multiply the length by the width, and that product by the height, which will give you the number of cubic feet. Divide that product by 128, and the quotient will be the number of cords.

A pile of wood 4 feet wide, and 4 feet high, and 8 feet long, contains 1 *cord;* and a *cord foot* is 1 foot in length of such a pile, thus:



BOARD MEASURE.

To ascertain the contents (board measure) of boards, scantling, and plank.

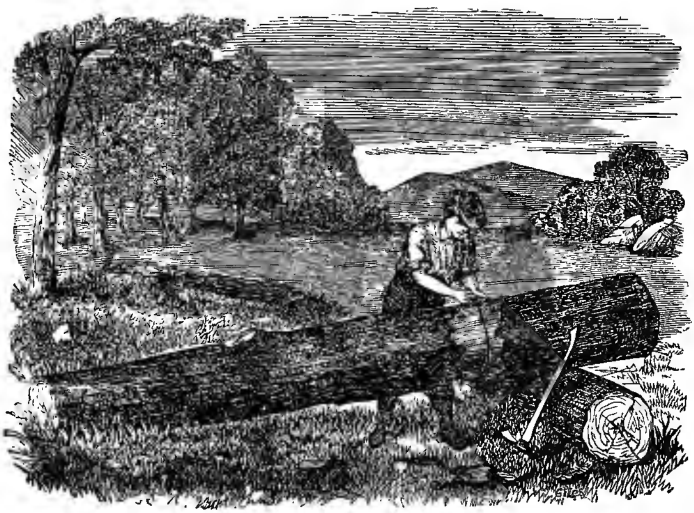
RULE.—Multiply the breadth in inches by the thickness in inches, and that by the length in feet, and divide the product by 12, and the quotient will be the contents.

TABLE, *showing the contents of inch-boards from 3 to 30 in. broad, and from 4 to 24 feet long.*

Ins.	LENGTH IN FEET.																				
	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
3	1.00	1.03	1.06	1.09	2.00	2.03	2.06	2.09	3.00	3.03	3.06	3.09	4.00	4.03	4.06	4.09	5.00	5.03	5.06	5.09	6.00
4	1.04	1.08	2.00	2.04	2.08	3.00	3.04	3.08	4.00	4.04	4.08	5.00	5.04	5.07	6.00	6.04	6.08	7.00	7.05	7.08	8.00
5	1.08	2.01	2.06	2.11	3.04	3.09	4.02	4.07	5.00	5.05	5.10	6.03	6.08	7.01	7.03	7.11	8.04	8.09	9.02	9.07	10.00
6	2.00	2.06	3.00	3.06	4.00	4.06	5.00	5.06	6.00	6.06	7.00	7.06	8.00	8.06	9.00	9.06	10.00	10.06	11.00	11.06	12.00
7	2.04	2.11	3.06	4.01	4.08	5.03	5.10	6.05	7.00	7.07	8.02	8.09	9.04	9.11	10.06	11.01	11.08	12.03	12.10	13.05	14.00
8	2.08	3.04	4.00	4.08	5.04	6.00	6.08	7.04	8.00	8.08	9.04	10.00	10.08	11.04	12.00	12.08	13.04	14.00	14.08	15.04	16.00
9	3.00	3.09	4.06	5.03	6 00	6.09	7.06	8.03	9.00	9.09	10.06	11.03	12.00	12.09	13.06	14.03	15.00	15.09	16.06	17.03	18.00
10	3.04	4.02	5.00	5.10	6.08	7.06	8.04	9.02	10.00	10.10	11.08	12.06	13.04	14.02	15.00	15.10	16.08	17.06	18.04	19.02	20.00
11	3.08	4.07	5.06	6.05	7.04	8.03	9.02	10.01	11.00	11.11	12.10	13.09	14.06	15.07	16.06	17.05	18.04	19.03	20.00	21.01	22.00
12	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00
13	4.04	5.05	6.06	7.07	8.08	9.09	10.10	11.11	13.00	14.01	15.02	16.03	17.04	18.05	19.06	20.07	21.08	22.09	23.10	24.11	26.00
14	4.08	5.10	7.00	8.02	9.04	10.06	11.08	12.10	14.00	15.02	16.04	17.06	18.08	19.10	21.00	22.02	23.04	24.06	25.08	26.10	28.00
15	5.00	6.03	7.06	8.09	10.00	11.03	12.06	13.09	15.00	16.03	17.06	18.09	20.00	21.03	22.06	23.09	25.00	26.03	27.06	28.09	30.00
16	5.04	6.08	8.00	9.04	10.08	12.00	13.04	14.08	16.00	17.04	18.08	20.00	21.04	22.08	24.00	25.04	26.08	28.00	29.04	30.08	32.00
17	5.08	7.01	8.06	9.11	11.04	12.09	14.02	15.07	17.00	18.05	19.10	21.03	22.08	24.01	25.06	26.11	28.04	29.09	31.02	32.07	34.00
18	6.00	7.06	9.00	10.06	12.00	13.06	15.00	16.06	18.00	19.06	21.00	22.06	24.00	25.06	27.00	28.06	30.00	31.06	33.00	34 06	36.00
19	6.04	7.11	9.06	11.01	12.08	14.03	15.10	17.05	19.00	20.07	22.02	23.09	25.04	26.11	28.06	30.01	31.08	33.03	34.10	36.05	38.00
20	6.08	8.04	10.00	11.08	13.04	15.00	16.08	18.04	20.00	21.08	23.04	25.00	26.08	28.04	30.00	31.08	33.04	35.00	36.08	38.04	40.00
21	7.00	8.09	10.06	12.03	14.00	15.09	17.06	19.03	21.00	22.09	24.06	26.03	28.00	29.09	31.06	33.03	35.00	36.09	38.06	40.03	42.00
22	7.04	9.02	11.00	12.10	14.08	16.06	18.04	20.02	22.00	23.10	25.08	27.06	29.04	31.02	33.00	34.10	36.08	38.06	40.04	42.03	44.00
23	7.08	9.07	11.06	13.05	15.04	17.03	19.02	21.01	23.00	24.11	26.10	28.09	30.08	32.07	34.06	36.05	38.04	40.03	43.02	44.01	46.00
24	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00	26.00	28.00	30.00	32.00	34.00	36.00	38.00	40.00	42.00	44.00	46.00	48.00
25	8.04	10.05	12.06	14.07	16.08	18.09	20.10	22.11	25.00	27.01	29.02	31.03	33.04	35.05	37.06	39.07	41.08	43.09	45.10	47.11	50.00
26	8.08	10.10	13.00	15.02	17.04	19.06	21.08	23.10	26.00	28.02	30.04	32.06	34.08	36.10	39.00	41.02	43.04	45.06	47.08	49.10	52.00
27	9.00	11.03	13.06	15.09	18.00	20.03	22.06	24.09	27.00	29.03	31.06	33.09	36.00	38.03	40.06	42.09	45.00	47.03	49.06	51.09	54.00
28	9.04	11.08	14.00	16.04	18.08	21.00	23.04	25.08	28.00	30.04	32.08	35.00	37.04	39.08	42.00	44.04	46.08	49.00	51.04	53.08	56.00
29	9.08	12.01	14.06	16.11	19.04	21 09	24 02	26.07	29.00	31.05	33.10	36.03	38.08	41.01	43.06	45 11	48.04	50.09	53.02	55.07	58.00
30	10.00	12.06	15.00	17.06	20.00	22.06	25.00	27.06	30.00	32.06	35.00	37.06	40.00	42.06	45.00	47.06	50.00	52.06	55.00	57.06	60.00

Explanation.—First find the width in inches in the left hand column, and the length in feet at the heads of the other columns; then trace the two until they meet, and the figures so found will express the contents in feet and inches.

ROUND TIMBER.



Round timber when squared is estimated to lose *one-fifth;* hence a ton of round timber is said to contain only 40 cubic feet.

Sawed lumber, as joists, plank, and scantlings, are now generally bought and sold by *board measure.* The dimensions of a *foot* of board measure is 1 foot long, 1 ft. wide, and 1 inch thick.

To measure round timber.

RULE.—Take the girth in inches at both the large and small ends, add them, and divide their sum by two for the mean girth; then multiply the length in feet by the square of one-fourth of the mean girth in inches, divide the product by 144, and the quotient will be the contents in cubic feet.

EXAMPLE.—What are the cubic contents of a round log 12 feet long, 54 inches girth at the large end, and 34 at the small end?

SOLUTION.—$54+34=88\div2=44$ inches, mean girth.

Then 12 length × 121 inches (the square of $\frac{1}{4}$ mean girth) $=1452\div144=10\frac{1}{12}$ cubic feet. *Ans.*

SQUARE TIMBER.

To measure square timber.

RULE.—Multiply the breadth in inches by the depth in inches, and that by the length in feet, and divide the product by 144, and the quotient will be the contents in cubic feet.

EXAMPLE.—What is the cubic contents of a square log 12 feet long by 20 inches broad and 18 deep?

SOLUTION.—$20\times18=360\times12=4320\div144=30$ cubic feet. *Ans.*

PLANK MEASURE.

TABLE, *showing the contents (board measure) of planks of various dimensions.*

Feet long	1¾by10	1¾by11	1¾by12	1¾by13	1¾by14	1¾by15	1¾by16	1¾by17	1¾by18	1¾by19	1¾by20	1¾by21	1¾by22	1¾by23	1¾by24	1¾by25	1¾by26	1¾by27	2 by 12	2 by 13	2 by 14	2 by 15	2 by 16	2 by 17	2 by 18	2 by 19
24	35	39	42	45	49	52	56	59	63	66	70	74	77	81	84	88	91	94	48	52	56	60	64	68	72	76
25	36	40	44	47	51	55	59	62	66	69	73	77	80	84	87	91	95	98	50	54	58	62	67	71	75	79
26	38	42	45	49	53	57	61	64	68	72	76	80	83	87	91	95	99	102	52	56	61	65	69	74	78	82
27	39	43	47	51	55	59	63	67	71	74	79	83	87	91	94	98	102	106	54	59	63	67	72	76	81	85
28	41	45	49	53	57	61	65	69	73	77	82	86	90	94	98	102	106	110	56	61	65	70	75	77	84	89
29	42	47	51	55	59	63	68	72	76	80	85	89	93	97	101	106	110	114	58	63	68	72	77	82	87	92
30	43	48	52	57	61	65	70	74	79	83	87	92	96	101	105	109	114	118	60	65	70	75	80	85	90	95
31	45	50	54	59	63	68	72	77	81	85	90	95	99	104	108	113	118	122	62	67	72	77	83	88	93	98
32	47	51	56	61	65	70	75	79	84	88	93	98	103	107	112	117	121	126	64	69	75	80	85	91	96	101
33	48	53	58	63	67	72	77	82	87	91	96	101	106	111	115	120	125	130	66	71	77	82	88	93	99	104
34	49	55	59	64	69	74	79	84	89	93	99	104	109	114	119	124	129	134	68	74	79	85	91	96	102	108
35	51	56	61	66	71	76	82	87	92	95	102	107	112	117	122	128	133	138	70	76	82	87	93	99	105	111
36	52	58	63	68	73	79	84	89	94	98	105	110	115	121	126	131	136	142	72	78	84	90	96	102	108	114
37	54	59	65	70	75	81	86	92	97	101	108	114	119	124	129	135	140	146	74	80	86	92	99	105	111	117
38	55	61	66	72	77	83	89	94	100	104	111	117	122	127	133	138	144	150	76	82	89	95	101	108	114	120
39	57	63	68	74	80	85	91	97	102	107	114	120	125	131	136	142	148	154	78	84	91	97	104	110	117	123
40	58	64	70	76	82	87	93	99	105	109	117	123	128	134	140	146	152	158	80	87	93	100	107	113	120	127
41	60	67	72	78	84	90	96	102	108	112	120	126	132	137	143	149	155	162	82	89	96	102	109	116	123	130
42	61	69	73	80	86	92	98	104	110	115	122	129	135	141	147	153	159	166	84	91	98	105	112	119	126	133
43	62	71	75	82	88	94	100	108	113	118	125	132	138	144	150	156	163	170	86	93	100	107	115	122	129	136
44	64	73	77	83	90	96	103	109	115	121	128	135	141	147	154	160	167	174	88	95	103	110	117	125	132	139
45	65	74	79	85	92	98	105	112	118	123	131	138	144	151	157	164	171	178	90	97	105	112	120	127	135	142
46	67	76	80	87	94	101	107	114	121	126	134	141	148	154	161	167	174	180	92	99	107	115	123	130	138	146
47	68	78	82	89	96	103	110	117	123	129	137	144	151	158	164	171	178	184	94	102	110	117	125	133	141	149
48	70	79	84	91	98	105	112	119	126	132	140	147	154	161	168	174	182	188	96	104	112	120	128	136	144	152
49	71	80	86	93	100	107	114	121	129	134	143	150	157	164	171	178	186	192	98	106	114	122	131	139	147	155
50	73	82	88	94	102	109	117	124	131	136	146	153	160	168	175	182	190	196	100	108	117	125	133	142	150	158
51	74	83	89	97	104	112	119	126	134	139	149	156	164	171	178	185	193	200	102	110	119	127	136	144	153	161
52	76	84	91	99	106	114	121	129	136	141	152	159	167	174	182	189	197	204	104	112	121	130	139	147	156	165

Table continued.

Feet long.	2 by 20	2 by 21	2 by 22	2 by 23	2 by 24	2 by 25	2 by 26	2 by 27	2 by 28	2¼by10	2¼by11	2¼by12	2¼by13	2¼by14	2¼by15	2¼by16	2¼by17	2¼by18	2¼by19	2¼by20	2¼by21	2¼by22	2¼by23	2¼by24	2¼by25	2¼by26	2¼by27	2½by12
24	80	84	88	92	96	100	104	108	112	45	49	54	58	64	68	72	77	80	86	90	95	99	104	108	113	117	121	60
25	83	87	92	96	100	104	108	112	117	47	52	56	61	66	70	75	80	84	89	94	98	103	108	112	117	122	127	62
26	87	91	95	101	104	108	113	117	121	49	54	59	63	68	73	78	83	88	93	97	102	107	112	117	122	127	132	65
27	90	94	99	103	108	112	117	121	126	51	56	61	66	71	76	81	86	91	96	101	106	111	116	121	127	132	137	67
28	93	98	103	107	112	117	121	126	131	52	58	63	68	73	79	84	89	94	100	105	110	115	121	126	131	136	142	70
29	97	101	106	111	116	121	126	130	139	54	60	65	71	76	82	87	92	98	103	109	114	119	125	130	136	141	147	72
30	100	105	110	115	120	125	130	135	140	56	62	68	73	79	84	90	96	101	107	112	118	123	129	135	141	146	152	75
31	103	108	114	119	124	129	134	139	145	58	64	70	76	81	87	93	99	105	110	116	122	127	134	139	145	151	157	77
32	107	112	117	123	128	133	139	144	149	60	66	72	78	84	90	96	101	108	114	120	126	131	138	144	150	156	162	80
33	110	115	121	126	132	137	143	148	154	62	68	74	80	86	93	99	104	111	118	124	130	135	142	148	155	161	167	82
34	113	119	125	130	136	141	147	153	159	64	70	77	83	89	96	102	109	115	121	127	134	140	147	153	159	166	172	85
35	117	122	128	134	140	146	152	157	163	66	72	79	85	92	98	105	112	118	125	131	138	144	151	157	164	171	177	87
36	120	126	132	138	144	150	156	162	168	67	74	81	88	94	101	108	115	121	128	135	142	148	155	162	169	175	182	90
37	123	129	136	142	148	154	160	166	173	69	76	83	90	97	104	111	118	125	132	139	146	152	160	166	173	180	187	92
38	127	133	139	146	152	158	165	171	177	71	78	86	92	100	107	114	121	128	135	143	150	156	164	171	178	185	192	95
39	130	136	143	149	156	162	169	175	182	73	80	88	95	102	110	117	124	131	139	146	154	160	168	175	183	190	197	97
40	133	140	147	153	160	167	173	180	187	75	82	90	97	105	112	120	128	135	142	150	158	164	172	180	187	195	202	100
41	137	143	150	157	164	171	178	184	191	77	85	92	100	107	115	123	131	138	146	154	162	168	177	184	192	200	207	102
42	140	147	154	161	168	175	182	189	196	79	87	95	102	110	118	126	134	142	150	158	166	172	181	189	197	205	213	105
43	143	150	158	165	172	179	186	193	201	81	89	97	105	113	122	129	137	145	153	162	170	177	185	193	201	210	218	107
44	147	154	161	169	176	183	191	198	205	83	91	99	107	115	125	132	140	148	157	165	174	181	190	198	206	215	223	110
45	150	157	165	172	180	187	195	202	210	84	93	102	110	118	127	135	144	152	160	169	178	185	194	202	211	220	228	112
46	153	160	169	176	184	192	199	207	215	86	95	104	112	121	130	138	147	155	164	173	182	189	198	207	215	224	232	115
47	157	164	172	180	188	196	204	211	219	88	97	106	115	123	133	141	150	159	167	176	186	193	203	211	220	229	238	817
48	160	168	176	184	192	200	208	216	224	90	99	108	117	126	136	144	153	162	171	180	189	197	207	216	225	234	243	120
49	163	171	180	188	196	204	212	220	229	92	101	111	119	128	139	147	156	165	175	183	193	201	211	220	229	239	248	122
50	167	175	183	192	200	208	217	225	233	94	103	113	122	131	141	150	159	169	178	187	197	205	215	225	234	244	253	125
51	170	178	187	195	204	213	221	229	238	96	105	115	124	134	144	153	163	172	182	191	201	210	220	229	239	249	258	127
52	173	182	190	199	208	217	225	234	243	98	107	117	127	136	146	156	166	175	185	185	205	214	224	234	244	254	263	130

Table continued.

Feet long	2½ by 13	2½ by 14	2½ by 15	2½ by 16	2½ by 17	2½ by 18	2½ by 19	2½ by 20	2½ by 21	2½ by 22	2½ by 23	2½ by 24	2½ by 25	2½ by 26	2½ by 27	2½ by 28	3 by 12	3 by 13	3 by 14	3 by 15	3 by 16	3 by 17	3 by 18	3 by 19	3 by 20	3 by 21	3 by 22	3 by 23
24	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	72	78	84	90	96	102	108	114	120	126	132	138
25	68	73	78	83	89	94	99	104	109	115	120	125	130	135	141	146	75	81	87	94	100	106	112	119	125	131	138	144
26	70	76	81	87	92	97	103	108	114	119	125	130	135	141	146	152	78	84	91	97	104	110	117	123	130	136	143	149
27	73	79	84	90	96	101	107	112	118	124	129	135	141	146	152	157	81	88	94	101	108	115	121	128	135	141	149	155
28	76	82	87	93	99	105	111	117	122	128	134	140	146	152	158	163	84	91	98	105	112	119	126	133	140	147	154	161
29	79	85	91	97	103	109	115	121	127	133	139	145	151	157	163	169	87	94	101	109	116	123	130	138	145	152	160	167
30	81	87	91	100	106	112	119	125	131	137	144	150	156	163	169	175	90	98	105	112	120	127	135	142	150	157	65	172
31	84	90	97	103	110	116	123	129	136	142	148	155	161	168	175	181	93	101	108	116	124	132	139	147	155	163	171	178
32	86	93	100	107	113	120	127	133	140	147	153	160	167	173	180	187	96	104	112	120	128	136	144	151	160	168	176	184
33	89	96	103	110	117	124	131	137	144	151	158	165	172	179	186	192	99	107	115	124	132	140	149	156	165	173	182	190
34	92	99	106	113	120	127	135	142	149	156	163	170	177	184	191	198	102	111	119	127	136	144	153	161	170	178	187	195
35	95	102	109	117	124	131	139	146	153	160	168	175	182	190	197	204	105	114	122	131	140	149	157	166	175	184	193	201
36	97	105	113	120	127	135	143	150	157	165	172	180	187	195	203	210	108	117	126	135	144	153	162	170	180	189	198	217
37	100	108	116	123	131	139	147	154	162	170	177	185	193	200	208	216	111	120	129	139	148	157	166	176	185	194	204	213
38	103	111	119	127	135	142	150	158	166	174	182	190	198	206	214	222	114	123	133	142	152	161	171	180	190	199	209	218
39	106	114	122	130	138	146	154	162	171	179	187	195	203	211	220	227	117	127	136	146	156	166	175	185	195	204	215	224
40	108	117	125	133	142	150	158	168	175	183	192	200	208	217	225	233	120	130	140	150	160	170	180	189	200	210	220	230
41	111	120	128	137	145	154	162	171	179	188	196	205	214	222	231	239	123	133	143	154	164	174	184	194	205	215	226	236
42	114	122	131	140	149	157	166	175	184	192	201	210	219	228	237	245	126	136	147	157	168	178	189	199	210	220	231	241
43	116	125	134	143	152	161	170	179	188	197	206	215	224	233	242	251	129	140	150	161	172	183	193	204	215	226	36	247
44	119	128	137	147	156	165	174	183	192	202	211	220	229	238	248	256	132	143	154	165	176	187	198	208	220	231	42	253
45	122	131	140	150	159	169	178	187	197	206	216	225	234	244	253	262	135	146	157	169	180	191	202	213	225	236	47	259
46	125	134	144	153	163	172	182	192	201	211	220	230	240	249	259	268	138	149	161	172	184	195	207	218	230	241	53	264
47	127	137	147	157	166	176	186	196	206	215	225	235	245	255	265	274	141	152	164	176	188	200	211	223	235	247	58	270
48	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	144	156	168	180	192	204	216	227	240	252	64	276
49	133	143	153	163	174	184	194	204	215	225	235	245	255	265	276	286	147	159	171	184	196	208	220	232	245	257	69	282
50	135	146	156	167	177	187	198	208	219	229	240	250	260	271	282	292	150	162	175	187	200	212	225	237	250	262	75	287
51	138	149	159	170	181	191	202	212	223	234	244	255	266	276	289	298	153	165	178	191	204	217	229	242	255	268	80	293
52	141	152	162	173	185	195	206	216	227	238	249	260	270	282	293	303	156	169	181	195	208	221	234	246	260	273	86	299

Table continued.

Feet long.	3 by 24	3 by 25	3 by 26	3 by 27	3 by 28	3 by 29	3 by 30	3½by15	3½by16	3½by17	3½by18	3½by19	3½by20	3½by21	3½by22	3½by23	3½by24	3½by25	3½by26	3½by27	3½by28	3½by29	3½by30	4 by 15	4 by 16
24	144	150	156	162	168	174	180	105	112	119	126	133	140	147	154	161	168	175	182	189	196	203	210	120	128
25	150	156	162	169	175	181	187	109	117	124	131	139	146	153	16	168	175	182	190	197	204	211	219	125	133
26	156	162	169	175	182	188	195	114	121	129	136	144	152	159	167	174	182	190	197	205	212	220	227	130	139
27	162	169	175	182	189	196	202	118	126	134	142	150	157	165	173	181	189	197	205	213	220	228	236	135	144
28	168	175	182	189	196	203	210	122	131	139	147	155	163	172	180	188	196	204	212	220	229	237	245	140	149
29	174	181	188	196	203	210	217	127	135	144	152	161	169	178	186	195	203	211	220	228	237	245	254	145	155
30	180	187	195	202	210	217	225	131	140	149	157	167	175	184	192	201	210	219	227	236	245	254	262	150	160
31	186	194	201	209	217	225	232	136	145	154	163	172	181	190	19	208	217	226	235	244	253	262	271	155	165
32	192	200	208	216	224	232	240	140	149	159	168	177	187	196	205	215	224	233	243	252	261	271	280	160	171
33	198	266	214	223	231	239	247	144	154	164	173	183	192	202	212	221	231	241	250	260	269	279	289	165	176
34	204	212	221	225	238	246	255	149	159	169	178	188	198	208	218	228	238	248	258	268	278	287	297	170	181
35	210	219	227	236	215	254	262	153	163	174	184	194	204	214	225	235	245	255	265	276	286	296	306	175	187
36	216	225	234	243	252	261	270	157	168	178	189	200	210	221	231	241	252	262	273	283	294	304	315	180	192
37	222	231	240	250	259	268	277	162	173	183	194	205	216	227	237	248	259	269	281	291	302	313	324	185	197
38	228	237	247	256	266	275	285	166	177	188	199	211	222	233	244	255	266	277	288	299	310	321	332	190	203
39	234	244	253	263	273	283	292	171	182	193	205	216	227	239	250	262	273	284	296	307	318	330	341	195	208
40	240	250	260	270	280	290	300	175	186	198	210	222	233	245	257	268	280	292	303	315	327	338	350	200	213
41	246	256	266	277	287	297	307	179	191	203	215	227	239	251	263	275	287	299	311	323	335	346	359	205	219
42	252	262	273	283	294	304	315	184	196	208	220	233	245	257	269	282	294	306	318	331	343	355	367	210	224
43	258	269	279	290	301	312	322	188	200	213	226	238	251	263	276	288	301	313	326	339	351	363	376	215	229
44	264	275	286	297	08	319	330	192	205	218	231	244	257	269	282	295	308	320	333	346	359	372	385	220	235
45	270	281	292	304	315	326	337	197	210	223	236	249	262	275	289	302	315	328	341	354	367	380	394	225	240
46	276	287	299	310	322	333	345	201	214	228	242	255	268	281	295	309	322	335	349	362	375	389	402	230	245
47	282	294	305	317	329	341	352	206	219	233	247	260	274	287	302	315	329	342	356	370	384	397	411	235	251
48	288	300	312	324	336	348	360	210	224	238	252	266	280	294	308	322	336	350	364	378	392	406	420	240	256
49	294	306	318	331	343	355	367	214	228	243	257	271	286	300	314	329	343	356	372	386	400	414	429	245	261
50	300	312	325	337	350	362	375	219	233	248	262	277	292	306	321	336	350	365	379	394	408	423	437	250	267
51	306	319	331	344	357	370	382	223	238	253	268	282	296	312	327	342	357	372	387	402	416	431	446	255	272
52	312	325	338	351	364	377	390	227	242	258	273	288	303	318	334	348	364	379	394	409	424	440	454	260	278

Table continued.

Feet long.	4 by 17	4 by 18	4 by 19	4 by 20	4 by 21	4 by 22	4 by 23	4 by 24	4 by 25	4 by 26
24	136	144	152	160	168	176	184	192	200	208
25	142	150	158	167	175	183	192	200	208	217
26	147	156	165	173	182	191	199	208	217	225
27	153	162	171	180	189	198	207	216	225	234
28	159	168	177	187	196	205	215	224	233	243
29	164	174	184	193	203	213	222	232	242	251
30	170	180	190	200	210	220	230	240	250	260
31	176	186	196	207	217	227	238	248	258	269
32	181	192	203	213	224	235	245	256	267	277
33	187	198	209	220	231	242	253	264	275	286
34	193	204	215	227	238	249	261	272	283	295
35	198	210	222	233	245	257	268	280	291	303
36	204	216	228	240	252	264	276	288	300	312
37	210	222	234	247	259	271	284	296	308	321
38	215	228	241	253	266	279	291	304	317	329
39	221	234	247	260	273	286	299	312	325	338
40	227	240	253	267	280	293	307	320	833	347
41	232	246	260	273	287	301	314	328	342	355
42	238	252	266	280	294	308	322	336	350	364
43	244	258	272	287	301	315	330	344	358	373
44	249	264	279	293	308	322	337	352	367	381
45	255	270	285	300	315	33	345	360	375	390
46	261	276	291	307	322	337	353	368	383	399
47	266	282	298	313	329	345	360	376	392	407
48	272	288	304	320	336	352	368	384	400	416
49	278	294	310	327	343	359	376	392	408	425
50	283	300	317	333	350	367	383	400	417	433
51	289	306	323	340	357	374	391	408	425	442
52	294	312	329	346	364	381	399	416	434	450

EXPLANATION.—Find the length in feet in the left hand column, and the width and thickness in inches at the heads of the other columns, and trace the two until they meet, and the figures so found will express the contents in feet, board measure. For a less length than any provided in the table, take the ½, ⅓, ¼, &c., of the lengths given. Thus for 6 feet take ¼ of 24, &c.

LOGS REDUCED TO INCH-BOARD MEASURE.

TABLE, *showing the number of feet (board measure) of inch-boards contained in round saw logs of various dimensions*

L. Feet.	Diam. 12	Diam. 13	Diam. 14	Diam. 15	Diam. 16	Diam. 17	Diam. 18	Diam. 19	Diam. 20	Diam. 21	Diam. 22	Diam. 23	Diam. 24	Diam. 25	Diam. 26	Diam. 27	Diam. 28	Diam. 29
10	49	61	72	89	99	116	133	150	175	191	209	235	252	287	313	342	363	381
11	54	67	79	98	109	127	147	165	192	209	230	259	278	315	344	377	400	419
12	59	73	86	107	119	139	160	180	210	228	251	283	303	344	375	411	436	457
13	64	79	93	116	129	150	173	195	227	247	272	306	328	373	408	445	473	495
14	69	85	100	125	139	162	187	210	245	266	292	330	353	401	439	479	509	533
15	74	91	107	134	149	173	200	225	262	285	313	353	379	430	469	514	545	571
16	79	97	114	142	159	185	213	240	280	304	334	377	404	459	500	548	582	609
17	81	103	122	151	168	196	227	255	297	323	355	400	429	478	531	582	618	647
18	88	109	129	160	178	208	240	270	315	342	370	424	454	510	562	610	654	685
19	93	116	136	169	188	219	253	285	332	361	397	447	480	545	594	650	692	723
20	9[illegible]	122	143	178	198	232	267	300	350	380	418	470	505	573	625	684	728	761
21	103	128	150	187	208	243	280	315	368	399	439	495	530	602	656	719	764	800
22	108	134	157	196	218	255	293	330	385	418	460	518	555	631	688	753	800	838
23	113	140	164	205	228	266	307	345	403	437	480	542	571	659	719	787	837	876
24	118	146	172	214	238	278	320	360	420	450	501	566	606	688	750	821	873	914
25	123	152	179	223	248	289	333	375	438	475	522	589	631	717	781	856	910	952

L. Feet.	Diam. 30	Diam. 31	Diam. 32	Diam. 33	Diam. 34	Diam. 35	Diam. 36	Diam. 37	Diam. 38	Diam. 39	Diam. 40	Diam. 41	Diam. 42	Diam. 43
10	411	444	460	490	500	547	577	644	669	70	752	795	840	872
11	451	448	506	539	550	602	634	708	734	770	828	874	924	959
12	493	532	552	588	600	657	692	772	801	840	903	954	1007	1046
13	534	576	598	637	650	712	750	836	868	910	978	1033	1091	1135
14	575	622	644	686	700	766	807	901	934	980	1053	1113	1175	1222
15	616	666	690	735	750	821	865	965	1001	1050	1129	1192	1259	1309
16	657	710	736	784	800	876	923	1029	1068	1120	1204	1272	1343	1396
17	698	755	782	833	850	931	980	1094	1134	1190	1279	1351	1427	1485
18	739	799	828	882	900	985	1038	1158	1201	1260	1354	1431	1511	1571
19	78	843	874	931	950	1040	1096	1222	1268	1330	1430	1510	1595	1658
20	821	888	920	980	1000	1095	1152	1287	1335	1400	1505	1590	1679	1745
21	863	932	966	1029	1050	1150	1210							
22	904	976	1012	1078	1100	1204	1268							
23	945	1021	1058	1127	1150	1259	1322							
24	986	1065	1104	1176	1200	1314	1380							
25	1027	1109	1150	1225	1250	1369	1438							

EXPLANATION.—Find the length of the log in feet in the left hand column, and its mean diameter in inches (found by adding the two end diameters, and dividing their sum by two) at the heads of the other columns, and trace them until they meet, and the figures so found will express the number of feet board measure of inch-boards the log will furnish.

SCANTLING MEASURE.

TABLE, *showing the contents (board measure) of scantling of various dimensions.*

Feet Long.	2 by 2	2 by 3	2 by 4	2 by 5	2 by 6	2 by 7	2 by 8	2 by 9	2 by 10
1	0.4	0.6	0.8	0.10	1.	1.2	1.4	1.6	1.8
2	0.8	1.	1.4	1.8	2.	2.4	2.8	3.	3.4
3	1.	1.6	2.	2.6	3.	3.6	4.	4.6	5.
4	1.4	2.	2.8	3.4	4.	4.8	5.4	6.	6.8
5	1.8	2.6	3.4	4.2	5.	5.10	6.8	7.6	8.4
6	2.	3.	4.	5.	6.	7.	8.	9.	10.
7	2.4	3.6	4.8	5.10	7.	8.2	9.4	10.6	11.8
8	2.8	4.	5.4	6.8	8.	9.4	10.8	12.	13.4
9	3.	4.6	6.	7.6	9.	10.6	12.	13.6	15.
10	3.4	5.	6.8	8.4	10.	11.8	13.4	15.	16.8
11	3.8	5.6	7.4	9.2	11.	12.10	14.8	16.6	18.4
12	4.	6.	8.	10.	12.	14.	16.	18.	20.
13	4.4	6.6	8.8	10.10	13.	15.2	17.4	19.6	21.8
14	4.8	7.	9.4	11.8	14.	16.4	18.8	21.	23.4
15	5.	7.6	10.	12.6	15.	17.6	20.	22.6	25.
16	5.4	8.	10.8	13.4	16.	18.8	21.4	24.	26.8
17	5.8	8.6	11.4	14.2	17.	19.10	22.8	25.6	28.4
18	6.	9.	12.	15.	18.	21.	24.	27.	30.
19	6.4	9.6	12.8	15.10	19.	22.2	25.4	28.6	31.8
20	6.8	10.	13.4	16.8	20.	23.4	26.8	30.	33.4
21	7.	10.6	14.	17.6	21.	24.6	28.	31.6	35.
22	7.4	11.	14.8	18.4	22.	25.8	29.4	33.	36.8
23	7.8	11.6	15.4	19.2	23.	26.10	30.8	34.6	38.4
24	8.	12.	16.	20.	24.	28.	32.	36.	40.
25	8.4	12.6	16.8	20.10	25.	29.2	33.4	37.6	41.8
26	8.8	13.	17.4	21.8	26.	30.4	34.8	39.	43.4
27	9.	13.6	18.	22.6	27.	31.6	36.	40.6	45.
28	9.4	14.	18.8	23.4	28.	32.8	37.4	42.	46.8
29	9.8	14.6	19.4	24.2	29	33.10	38.8	43.6	48.4
30	10.	15.	20.	25.	30.	35.	40.	45.	50.

Table continued.

Feet Long.	2 by 11	2½ by 5	2½ by 6	2½ by 7	2½ by 8	2½ by 9	2½ by 10	2½ by 11	2½ by 12	3 by 3	3 by 4
1	1.10	1.1	1.3	1.6	1.8	1.11	2.1	2.4	2.6	0.9	1.
2	3.8	2.1	2.6	2.11	3.4	3.9	4.2	4.7	5.	1.6	2.
3	5.6	3.2	3.9	4.5	5.	5.8	6.3	6.11	7.6	2.3	3.
4	7.4	4.2	5.	5.10	6.8	7.6	8.4	9.2	10.	3.	4.
5	9.2	5.3	6.3	7.4	8.4	9.5	10.5	11.6	12.6	3.9	5.
6	11.	6.3	7.6	8.9	10.	11.3	12.6	13.9	15.	4.6	6.
7	12.10	7.4	8.9	10.3	11.8	13.2	14.7	16.1	17.6	5.3	7.
8	14.8	8.4	10.	11.8	13.4	15.	16.8	18.4	20.	6.	8.
9	16.6	9.5	11.3	13.2	15.	16.11	18.9	20.8	22.6	6.9	9.
10	18.4	10.5	12.6	14.7	16.8	18.9	20.10	22.11	25.	7.6	10.
11	20.2	11.6	13.9	16.1	18.4	20.8	22.11	25.3	27.6	8.3	11.
12	22.	12.6	15.	17.6	20.	22.6	25.	27.6	30.	9.	12.
13	23.10	13.7	16.3	19.	21.8	24.5	27.1	29.10	32.6	9.9	13.
14	25.8	14.7	17.6	20.5	23.4	26.3	29.2	32.1	35.	10.6	14.
15	27.6	15.8	18.9	21.11	25.	28.2	31.3	34.4	37.6	11.3	15.
16	29.4	16.8	20.	23.4	26.8	30.	33.4	36.8	40.	12.	16.
17	31.2	17.9	21.3	24.10	28.4	31.11	35.5	39.	42.6	12.9	17.
18	33.	18.9	22.6	26.3	30.	33.9	37.6	41.3	45.	13.6	18.
19	34.10	19.10	23.9	27.9	31.8	35.8	39.7	43.7	47.6	14.3	19.
20	36.8	20.10	25.	29.2	33.4	37.6	41.8	45.10	50.	15.	20.
21	38.6	21.11	26.3	30.8	35.	39.5	43.9	48.2	52.6	15.9	21.
22	40.4	22.11	27.6	32.1	36.8	41.3	45.10	50.5	55.	16.6	22.
23	42.2	24.	28.9	33.7	38.4	43.2	47.11	52.9	57.6	17.3	23.
24	44.	25.	30.	35.	40.	45.	50.	55.	60.	18.	24.
25	45.10	26.1	31.3	36.6	41.8	46.11	52.1	57.4	62.6	18.9	25.
26	47.8	27.1	32.6	37.11	43.4	48.9	54.2	59.7	65.	19.6	26.
27	49.6	28.2	33.9	39.5	45.	50.8	56.3	61.11	67.6	20.3	27.
28	51.4	29.2	35.	40.10	46.8	52.6	58.4	64.2	70.	21.	28.
29	53.2	30.3	36.3	42.4	48.4	54.5	60.5	66.6	72.6	21.9	29.
30	55.	31.3	37.6	43.9	50.	56.3	62.6	68.9	75.	22.6	30.

Table continued.

Feet Long.	3 by 5	3 by 6	3 by 7	3 by 8	3 by 9	3 by 10	3 by 11	3 by 12	4 by 4	4 by 5	4 by 6
1	1.3	1.6	1.9	2.	2.3	2.6	2.9	3	1.4	1.8	2.
2	2.6	3.	3.6	4.	4.6	5.	5.6	6	2.8	3.4	4.
3	3.9	4.6	5.3	6.	6.9	7.6	8.3	9.	4.	5.	6.
4	5.	6.	7.	8.	9.	10.	11.	12.	5.4	6.8	8.
5	6.3	7.6	8.9	10.	11.3	12.6	13.9	15.	6.8	8.4	10.
6	7.6	9.	10.6	12.	13.6	15.	16.6	18.	8.	10.	12.
7	8.9	10.6	12.3	14.	15.9	17.6	19.3	21.	9.4	11 8	14.
8	10.	12.	14.	16.	18.	20.	22.	24.	10.8	13.4	16.
9	11.3	13.6	15.9	18.	20.3	22.6	24.9	27.	12.	15.	18.
10	12.6	15.	17.6	20.	22.6	25.	27.6	30.	13.4	16.8	20.
11	13.9	16.6	19.3	22.	24.9	27.6	30.3	33.	14.8	18.4	22.
12	15.	18.	21.	24.	27.	30.	33.	36.	16.	20.	24.
13	16.3	19.6	22.9	26.	29.3	32.6	35.9	39.	17.4	21.8	26.
14	17.6	21.	24 6	28.	31.6	35.	38 6	42.	18.8	23.4	28.
15	18.9	22.6	26.3	30.	31.9	37.6	41.3	45.	20.	25.	30.
16	20.	24.	28.	32.	36.	40.	44.	48.	21.4	26.8	32.
17	21.3	25.6	29.9	34.	38.3	42.6	46.9	51.	22.8	28.4	34.
18	22.6	27.	31.6	36.	40.6	45.	49.6	54.	24.	30.	36.
19	23.9	28.6	33.3	38.	42.9	47.6	52.3	57.	25.4	31 8	38.
20	25.	30.	35.	40.	45.	50.	55.	60.	26.8	33.4	40.
21	26.3	31.6	36.9	42.	47.3	52.6	57.9	63.	28.	35.	42.
22	27.6	33.	38.6	44.	49.6	55.	60.6	66.	29.4	36.8	44.
23	28.9	31.6	40.3	46.	51.9	57.6	63.3	69.	30.8	38.4	46.
24	30.	36.	42.	48.	54.	60.	66.	72.	32.	40.	48.
25	31.3	37.6	43.9	50.	56.3	62.6	68.9	75.	33.4	41.8	50.
26	32.6	39.	45.6	52.	58.6	65.	71.6	78.	34 8	43.4	52.
27	33.9	40.6	47.3	54.	60.9	67.6	74.3	81.	36.	45.	54.
28	35.	42.	49.	56.	63.	70.	77.	84.	37.4	46.8	56.
29	36.3	43.6	50.9	58.	65.3	72.6	79.9	87.	38.8	48.4	58.
30	37.6	45.	52.6	60.	67.6	75.	82.6	90.	40.	50.	60.

Table continued.

Feet Long.	4 by 7	4 by 8	4 by 9	4 by 10	4 by 11	4 by 12	5 by 5	5 by 6	5 by 7	5 by 8	5 by 9
1	2.4	2.8	3.	3.4	3.8	4.	2.1	2.6	2.11	3.4	3.9
2	4.8	5.4	6	6.8	7.4	8.	4.2	5.	5.10	6.8	7.6
3	8.	8.	9.	10.	11.	12.	6.3	7.6	8.9	10.	11.3
4	9.4	10.8	12.	13.4	14.8	16.	8.4	10.	11.8	13.4	15.
5	11.8	13.4	15.	16.8	18.4	20.	10.5	12.6	14.7	16.8	18.9
6	14.	16.	18.	20.	22.	24.	12.6	15.	17.6	20.	22.6
7	16.4	18.8	21.	23.4	25.8	28.	14.7	17.6	20.5	23.4	26.3
8	18.8	21.4	24.	26.8	29.4	32.	16.8	20.	23.4	26.8	30.
9	21.	24.	27.	30.	33.	36.	18.9	22.6	26.3	30.	33.9
10	23.4	26.8	30.	33.4	36.8	40.	20.10	25.	29.2	33.4	37.6
11	25.8	29.4	33.	36.8	40.4	44.	22.11	27.6	32.1	36.8	41.3
12	28.	32.	36.	40.	44.	48.	25.	30.	35.	40.	45.
13	30.4	34.8	39.	43.4	47.8	52.	27.1	32.6	37.11	43.4	48.9
14	32.8	37.4	42.	46.8	51.4	56.	29.2	35.	40.10	46.8	52.6
15	35.	40.	45.	50.	55.	60.	31.3	37.6	43.9	50.	56.3
16	37.4	42.8	48.	53.4	58.8	64.	33.4	40.	46.8	53.4	60.
17	39.8	45.4	51.	56.8	62.4	68.	35.5	42.6	49.7	56.8	63.9
18	42.	48.	54.	60.	66.	72.	37.6	45.	52.6	60.	67.6
19	44.4	50.8	57.	63.4	69.8	76.	39.7	47.6	55.5	63.4	71.3
20	46.8	53.4	60.	66.8	73.4	80.	41.8	50.	58.4	66.8	75.
21	49.	56.	63.	70.	77.	84.	43.9	52.6	61.3	70.	78.9
22	51.4	58.8	66.	73.4	80.8	88.	45.10	55.	64.2	73.4	82.6
23	53.8	61.4	69.	76.8	84.4	92.	47.11	57.6	67.1	76.8	86.3
24	56.	64.	72.	80.	88.	96.	50.	60.	70.	80.	90.
25	58.4	66.8	75.	83.4	91.8	100.	52.1	62.6	72.11	83.4	93.9
26	60.8	69.4	78.	86.8	95.4	104.	54.2	65.	75.10	86.8	97.6
27	63.	72.	81.	90.	99.	108.	56.3	67.6	78.9	90.	101.3
28	65.4	74.8	84.	93.4	102.8	112.	58.4	70.	81.8	93.4	105.
29	67.8	77.4	87.	96.8	106.4	116.	60.5	72.6	84.7	96.8	108.9
30	70.	80.	90.	100.	110.0	120.	62.6	75.	87.6	100.	112.5

Table continued.

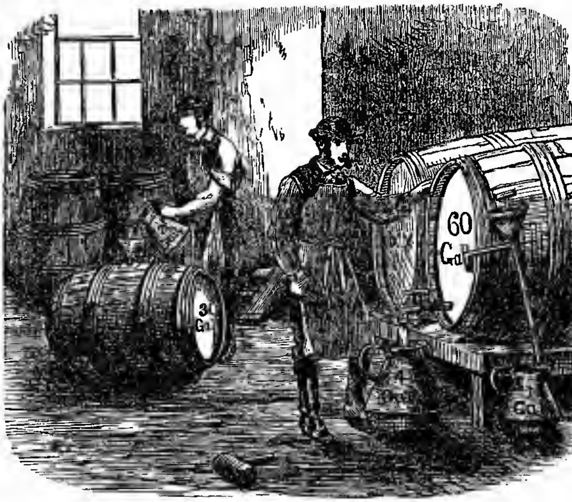
Feet Long.	5 by 10	6 by 6	6 by 7	6 by 8	7 by 7	7 by 8	7 by 9	8 by 8	8 by 9	8 by 10	9 by 9
1	4.2	3.	3.6	4.	4.1	4.8	5.3	5.4	6.	6.8	6.9
2	8.4	6.	7.	8.	8.2	9.4	10.6	10.8	12.	13.4	13.6
3	12.6	9.	10.6	12.	12.3	14.	15.9	16.	18.	20.	20.3
4	16.8	12.	14.	16.	16.4	18.8	21.	21.4	24.	26.8	27.
5	20.10	15.	17.6	20.	20.5	23.4	26.3	26.8	30.	33.4	33.9
6	25.	18.	21.	24.	24.6	28.	31.6	32.	36.	40.	40.6
7	29.2	21.	24.6	28.	28.7	32.8	36.9	37.4	42.	46.8	47.3
8	33.4	24.	28.	32.	32.8	37.4	42.	42.8	48.	53.4	54.
9	37.6	27.	31.6	36.	36.9	42.	47.3	48.	54.	60.	60.9
10	41.8	30.	35.	40.	40.10	46.8	52.6	53 4	60.	66.8	67.6
11	45.10	33.	38.6	44.	44.11	51.4	57.9	58.8	66.	73.4	74.3
12	50.	36.	42.	48.	49.	56.	63.	64.	72.	80.	81.
13	54.2	39.	45.6	52.	53.1	61.8	68.3	69.4	78.	86.8	87.9
14	58.4	42.	49.	56.	57.2	65.4	73.6	74.8	84.	93.4	94.6
15	62.6	45.	52.6	60.	61.3	70.	78.9	80.	90.	100.	101.3
16	66.8	48.	56.	64.	65.4	74.8	84.	85.4	96.	106.8	108.
17	70.10	51.	59.6	68.	69.5	79.4	89.3	90.8	102.	113.4	114.9
18	75.	54.	63.	72.	73.6	84.	94.6	96.	108.	120.	121.6
19	79.2	57.	66.6	76.	77.7	88.8	99.9	101.4	114.	126.8	128.3
20	83.4	60.	70.	80.	81.8	93.4	105.	106.8	120.	133.4	135.
21	87.6	63.	73.6	84.	85.9	98.	110.3	112.	126.	140.	141.9
22	91.8	66.	77.	88.	89.10	102.8	115.6	117.4	132.	146.8	148.6
23	95.10	69.	80.6	92.	93.11	107.4	120.9	122.8	138.	153.4	155.3
24	100.	72.	84.	96.	98.	112.	126.	128.	144.	160.	162.
25	104.2	75.	87.6	100.	102.1	116.8	131.3	133.4	150.	166.8	168.9
26	108.4	78.	91.	104.	106.2	121.4	136.6	138.8	156.	173.4	175.6
27	112.6	81.	94.6	108.	110.3	126.	141.9	144.	162.	180.	182.3
28	116.8	84.	98.	112.	114.4	130.8	147.	149.4	168.	186.8	189.
29	120.10	87	101.6	116.	118.5	135.4	152.3	154.8	171.	193.4	195.9
30	125.	90.	105.	120.	122.6	140.	157.6	160.	180.	200.	202.6

Table continued.

Feet Long.	9 by 10	9 by 11	10 by 10	10 by 11	10 by 12	11 by 11	11 by 12
1	7.6	8.3	8.4	9.2	10.	10.1	11.
2	15	16 6	16.8	18.4	20.	20.2	22.
3	22.6	24.9	25.	27.6	30.	30.3	33.
4	30.	33.	33.4	36.8	40.	40.4	44.
5	37.6	41.3	41.8	45.10	50.	50.5	55.
6	45.	49.6	50.	55.	60.	60.6	66.
7	52.6	57.9	58.4	64.2	70.	70.7	77.
8	60.	66.	66.8	73.4	80.	80.8	88.
9	67.6	74.3	75.	82.6	90.	90.9	99.
10	75.	82.6	83.4	91.8	100.	100.10	110.
11	82.6	90.9	91.8	100.10	110.	110.11	121.
12	90.	99.	100.	110.	120.	121.	132.
13	97.6	107.3	108.4	119.2	130.	131.1	143.
14	105.	115.6	116.8	128.4	140.	141.2	154.
15	112.6	123.9	125.	137.6	150.	151.3	165.
16	120.	132.	133.4	146.8	160.	161.4	176.
17	127.6	140.3	141.8	155.10	170.	171.5	187.
18	135.	148.6	150.	165.	180.	181.6	198.
19	142.6	156.9	158.4	174.2	190.	191.7	209.
20	150.	165.	166.8	183.4	200.	201.8	220.
21	157.6	173.3	175.	192.6	210.	211.9	231.
22	165.	181.6	183.4	201.8	220.	221.10	242.
23	172.6	189.9	191.8	210.10	230.	231.11	253.
24	180.	198.	200.	220.	240.	242.	264.
25	187.6	206.3	208.4	229.2	250.	252.1	275.
26	195.	214.6	216.8	238.4	260.	262 2	286.
27	202.6	222.9	225.	247.6	270.	272.3	297.
28	210.	231.	233.4	256.8	280.	282.4	308.
29	217.6	239.3	241.8	265.10	290.	292.5	319.
30	225.	247.6	250.	275.	300.	302.6	330.

EXPLANATION.—Find the length in feet in the left hand column, and the dimensions of the sides in inches at the head of the other column, and underneath the latter and opposite the length will be found the contents in feet and inches board measure.

CASK-GAUGING.



Casks are usually comprised under the following figures, viz.:

1. The middle frustum of a spheroid.
2. The middle frustum of a parabolic spindle.
3. The two equal frustums of a paraboloid.
4. The two equal frustums of a cone.

Their contents can be computed by the rules for ascertaining the contents of these figures.

But in almost all ordinary casks the *bilge* or *swell* from the *bung* to the head (not from head to head) is so small, that they are, with scarcely an appreciable difference in the results, usually regarded as the two equal frustums of a cone, and are very accurately gauged by three dimensions, as follows:

To find the contents of a cask by three dimensions.

RULE.—Add the bung and head diameters in inches, and divide them by 2 for the mean diameter; find the area of the mean diameter in the table of the areas of circles on page 298 and multiply it by the length of the cask in inches; then divide the product by 231 (the cubic inches in a gallon), and the quotient will be the number of gallons the cask contains.

EXAMPLE.—What are the contents in gallons of a cask, the bung diameter of which is 22 inches, the head diameter 20 inches, and the length 32 inches?

SOLUTION.—$22+20=42 \div 2=21$, mean diameter: then 346.36, area of mean diameter, $\times 32=11083.52 \div 231=$ 47.98 gallons. *Ans.*

When the cask is much bilged or rounded from the bung to the head, a more accurate way is to gauge by four dimensions, as follows:

To find the contents of a cask by four dimensions.

RULE.—Add the head and bung diameters in inches, and the diameter taken in inches in the middle between the bung and head, and divide their sum by 3 for the mean diameter; find the area of the mean diameter in the table of the areas of circles on page 298 and multiply it by the length of the cask in inches and divide the product by 231 (the cubic inches in a gallon), and the quotient will be the contents of the cask in gallons.

Example.—What are the contents in gallons of a cask, the bung diameter of which is 24 inches, the middle diameter 20 inches, the head diameter 16 inches, and its length 40 inches?

Solution.—24 + 20 + 16 = 60 ÷ 3 = 20, mean diameter: then 314.16, area of mean diameter, × 40 inches, length = 12566.40 ÷ 231 = 54.4 galls. *Ans.*

CAPACITY OF BOXES.

A box 24 inches by 16 inches square, and 28 inches deep, will contain a barrel (5 bushels).

A box 24 inches square and 14 inches deep, will contain half a barrel.

A box 26 inches by 15.2 inches square, and 8 inches deep, will contain one bushel.

A box 12 inches by 11.2 inches square, and 3 inches deep, will contain half a bushel.

A box 8 inches by 8.4 inches square, and 8 inches deep, will contain one peck.

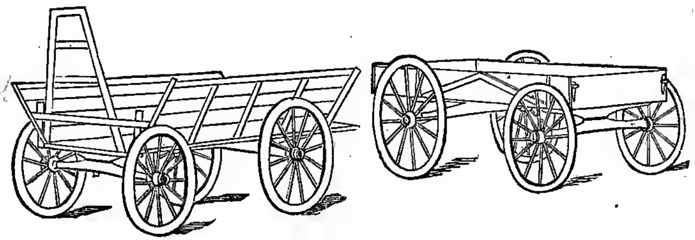
A box 8 inches by 8 inches square, and 4.2 inches deep, will contain one gallon.

A box 7 inches by 4 inches square, and 4.8 inches deep, will contain half a gallon.

A box 4 inches by 4 inches square, and 4.1 inches deep, will contain one quart.

4*

CAPACITY OF WAGON-BEDS.



Wagon-Beds.

In most of the Eastern and many of the Western cities all market-men and traders, who make use of their wagon-beds as measures, are required to have them gauged and their capacity stamped on them by an officer appointed for that purpose. The wagon-makers in the country should stamp the contents in bushels on each bed they make before it leaves the shop. Should it be neglected, the following rule will enable every farmer to measure the contents in bushels of his wagon-bed for himself:

To find the contents of wagon-beds.

Rule.—If the opposite sides are parallel, multiply the length inside in inches, by the breadth inside in inches, and that again by the depth inside in inches, and divide the product by 2150.42 (the number of cubic inches in a bushel), and the quotient will be the capacity in bushels.

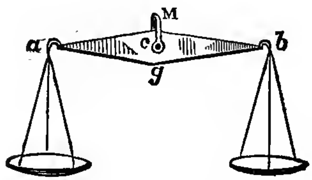
Example.—What is the capacity of a wagou-bed 10 feet long, 4 feet wide, and 15 inches deep?

Solution.—120 inches, length, ×48 inches, width, ×15 inches, depth, =86400÷2150.42=40 bushels. *Ans.*

Rule 2.—Should the head and tail boards, or either of them, be set in bevelling, add the top and bottom lengths together and divide by 2 for the mean length, and proceed by the foregoing rule. Shonld the sides be sloping, add the top and bottom widths, and divide by 2 for the mean width, and proceed by the foregoing rule.

Shonld the contents be required in cubic feet, divide the product by 1728 (the number of cubic inches in a cubic foot), instead of 2154.42, and the quotient will be the contents in cubic feet.

FALSE BALANCES.



To detect false balances, scales, &c.

RULE.—After weighing the article transpose the weight and the article weighed, and if the latter is too light the weight will preponderate; if too heavy the article will preponderate.

To find the true weight.

RULE.—After transposing them as above, find the additional weight that will produce an equilibrium: weigh it with the article by the same balances: multiply the two false weights thus found, together, and the square root of the product will be the true weight.

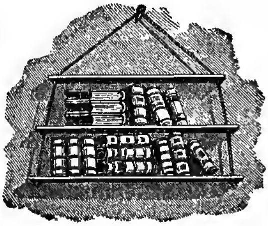
EXAMPLE.—An article weighs 7 lbs. by a false balance: transposed it is found *too light*, and requires an additional weight to produce a counterpoise: this additional weight is found by the same balances to have a false weight of $9\frac{1}{7}$ lbs. What is the true weight of the article?

SOLUTION.—$9\frac{1}{7} \times 7 = 64$, the square root of which is 8 lbs., the weight. *Ans.*

EXAMPLE 2.—An article weighs 7 lbs.: transposed it is found *too heavy*, weighing only $5\frac{1}{7}$ lbs. by the same scales. What is the true weight?

SOLUTION.—$7 \times 5\frac{1}{7} = 36$, the square root of which is 6 lbs., the true weight. *Ans.*

NOTE.—In the 1st example the additional weight is added to the article to produce the equilibrium: in the second example the deficiency is taken from the weight to produce the counterpoise.



CISTERNS.

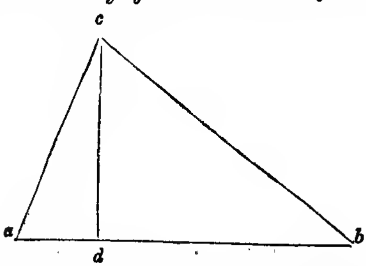
To find the number of gallons in square or oblong square cisterns.

RULE.—Multiply the length in inches by the width in inches, and that by the depth in inches, and divide the product by 231. The quotient will be the number of gallons.

EXAMPLE.—Given, a cistern 6 feet long by 3 feet wide and 4 feet deep; how many gallons will it contain?

SOLUTION.—72 inches, length, ×36 inches, width, ×48 inches, depth, =124416÷231=538.59 galls. *Ans.*

To find the number of gallons in triangular cisterns.



RULE.—Multiply the base *a b* in inches, by the perpendicular height *c d* in inches, and half that sum by the depth in inches, and divide the product by 231. The quotient will be the number of gallons.

EXAMPLE.—Given, a triangular cistern 8 feet at the base or longest side, 7 feet in perpendicular height, 4 feet deep. How many gallons will it contain?

SOLUTION.—96 inches, base, $\times 84$, perpendicular height in inches, $\div 2 = 4032 \times 48$, depth in inches, $= 112896 \div 231 = 488.72$ galls. *Ans.*

To find the number of gallons in circular cisterns.

RULE.—Find the area of the circle in square inches, in the table of the "Areas of Circles," on page 298, or by the rule given on page 296. Then multiply the area by the depth in inches, and divide the product by 231. The quotient will be the number of gallons.

EXAMPLE.—Given, a cistern 8 feet in diameter by 5 feet deep. How many gallons will it contain?

SOLUTION.—Area, the diameter being 96 inches	7238.2
Multiplied by 60 in., the depth, gives	43429.20
Divided by 231, cubic in. in a gall., "	1880. gall. *Ans.*

TABLE, *showing the contents of circular cisterns from* 1 *foot to* 25 *feet in diameter, for each* 10 *inches in depth.*

DIAMETER.	GALLONS.	DIAMETER.	GALLONS.
1	4.896	7½	271.072
1½	11.015	8	313.340
2	19.583	8½	353.735
2½	30.545	9	396.573
3	44.064	9½	441.861
3½	59.980	10	489.600
4	78.333	11	592.400
4½	99.116	12	705.
5	122.400	13	827.450
5½	148.546	14	959.613
6	176.253	15	1101.610
6½	206.855	20	1958.421
7	239.906	25	3059.934

To find the number of gallons in tub-shaped cisterns.

RULE.—Find the cubes of the top and bottom diameters in inches, by means of the table on page 303, divide the difference between those cubes by the difference of the diameters in inches, and multiply this quotient by .7854, and again by $\frac{1}{3}$ of the depth in inches, and divide the product by 231. The quotient will be the number of gallons.

EXAMPLE.—Given, a tub-shaped cistern of a top diameter of 10 feet, a bottom diameter of 8 feet, and 6 feet deep. How many gallons will it contain?

SOLUTION.—Cube of 120 inches, the top diameter,	1728000
" 96 " " bottom "	884736
Difference between cubes of diameters,	843264
Divided by 24, difference of diameters, gives	.35136
Multiplied by .7854, gives	27595.8144
" again by 24, $\frac{1}{3}$ the depth in inches, gives	662299.5456
Divided by 231, cubic inches in a gallon, gives	2867.09

galls. *Ans.*

RULE 2.—Add the top and bottom diameters in inches and divide by 2 for the mean diameter. Find the area in square inches of the mean diameter by means of the table on page 298 or by the rule given on page 296. Multiply the area by the depth in inches, and divide the product by 231, and the quotient will be the number of gallons.

EXAMPLE.—What are the contents in gallons of a cistern 8 feet diameter at the top, 6 feet at the bottom, and 4 feet deep?

SOLUTION.—96 inches + 72 inches = 168÷2=84 inches, mean diameter; then 5541.77, area of mean diameter, ×48 inches, depth,=266004.96÷231=1151.53 gallons. *Ans.*

NOTE.—The quantity of water which falls upon most farm buildings is sufficient to afford an ample supply for the domestic animals of the farm, when other supplies fail, were cisterns large enough to hold it provided. The average amount of rain that falls in the latitude of the Northern States during the year, is about 3 feet per year, or 3 inches per month. Every inch in depth that falls upon a roof yields 2 barrels for each ten feet square, and 72 barrels a year are yielded by 3 feet of rain. A barn 30 by 40 feet supplies annually from its roof 864 barrels, which is more than 2 barrels per day, the year round.

The size of cisterns should vary according to their intended use. If they are to furnish a *daily* supply of water, they need not be so large as for saving supplies against summer and droughts.

The size of the cistern in *daily* use need not exceed that of a body of water on the whole roof of the building, 7 inches deep, or two months' greatest fall of rain. Cisterns intended to save the water to draw from in time of drought, should be about three times as large.

To ascertain the size of cisterns adapted to roofs, &c.

RULE.—Multiply the length of the roof in inches by the breadth in inches, and that by the depth of the fall of rain required to be saved, and divide the product by 231, and the quotient will be the number of gallons. Divide the number of gallons by $31\frac{1}{2}$, and it will give the number of barrels.

Example.—What must be the capacity of a cistern to contain the water running from a roof 40 feet long by 30 wide, for 2 months: estimated fall of rain 7 inches?

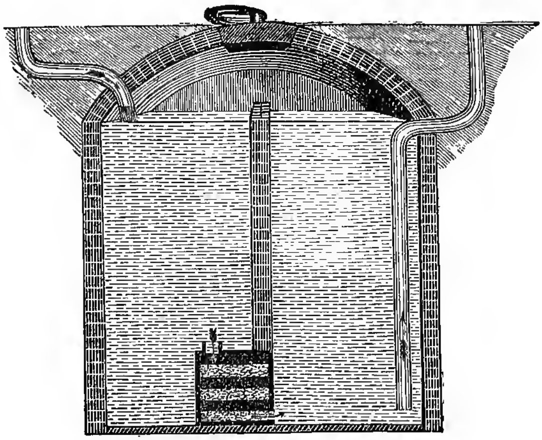
Solution.—480 inches, length, $\times 360$ inches, width, $\times 7$ inches, depth of rain, $=1909600 \div 231 = 8266\frac{2}{3}$ galls. *Ans.*

Note.—To ascertain the necessary dimensions of a cistern large enough to contain $8266\frac{2}{3}$ gallons, consult the foregoing table. It will there be found that a cistern 13 feet in diameter contains 827 gallons for each 10 inches in depth. To give the cistern 10 times that depth, or 100 inches ($8\frac{1}{3}$ feet) will make it contain 8270 gallons. Hence a cistern 13 feet in diameter, and $8\frac{1}{3}$ feet deep, will be large enough.

To further aid the inquirer in ascertaining the requisite diameters of cisterns for the above purposes, we subjoin an additional

Table, *showing the contents of circular cisterns in barrels for each foot in depth.*

5 feet	4.66
6 "	6.74
7 "	9.13
8 "	11.93
9 "	15.10
10 "	18.65



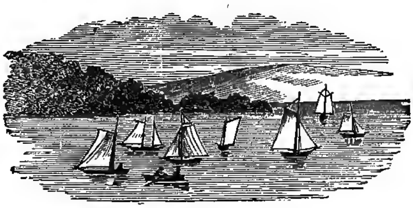
The above cut represents the sectional view of a filtered cistern, with a brick wall partition in the middle and the box of charcoal and sand at the bottom, with alternate layers of each. The pipe at the left leads from the roof, and the one at the right connects with the pump. With this style of cistern properly constructed, no one need be in want of pure wholesome water.

To construct a filtering cistern to furnish pure water for domestic use.

Rule.—Divide the cistern into two equal compartments by a wall of brick or stone, open at the bottom to the height of about six inches, and water-tight thence to the top. Let one compartment be for receiving the water, and the other for containing it when filtered and ready for use. Put alternate layers, 6 inches deep, of gravel, sand,

and pounded charcoal at the bottom of the former, and sand and gravel at the bottom of the latter. The former will receive the water from the pipe, and it will rise filtered in the latter.

ANOTHER MODE.—Divide the cistern as above by a double open wall of stone or brick, with an interspace of about six inches between the walls. Fill the interspace with sand and pounded charcoal. Let one compartment receive the water, and it will pass through the filter into the other ready for use.



HYDRAULICS.

The science of *hydraulics* treats of the motion of non-elastic fluids; *hydrodynamics*, of the force of that motion; and *hydrostatics*, of the pressure, weight, and equilibrium.

THE FUNDAMENTAL LAWS OF HYDRAULICS, &c.

1. Descending water is governed by the same laws as falling bodies.

2. Water will fall 1 foot in $\frac{1}{4}$ of a second, 4 feet in $\frac{1}{2}$ a second, and 9 feet in $\frac{3}{4}$ of a second, and so on in the same ratio.

3. The velocity of a fluid propelled through an orifice by a head of water in a cistern or reservoir, is the same that a body would acquire by falling perpendicularly through a space equal to that between the top of the head and the centre of the opening, *less the friction which, in pipes, drains, and sluices, increases as the square of the velocity.*

4. The mean velocity of water propelled through an opening by a head of 1 foot is $5\frac{3}{5}$ feet per second.

5. Fluids press equally in all directions.

6. The pressure of a fluid on the bottom of a vessel is as

the base and perpendicular height, whatever may be the figure of the vessel.

7. The pressure of a fluid on any kind of surface, horizontal, vertical, or oblique, is equal to the weight of the column of the fluid, the base of which is equal to the area of the surface pressed, and the height of which is equal to the distance from the surface of the fluid to its centre of gravity, on the surface pressed.

8. The side of a vessel filled with water sustains a pressure equal to the area of the side multiplied by half the depth, whether the sides be vertical, oblique, or horizontal.

9. If the vessel be tub-shaped, or in the form of an inverted frustum of a cone or pyramid, the bottom sustains a pressure equal to the area of the bottom and the depth of the fluid.

10. The quantity of water that will flow out of a perpendicular slit or aperture from the surface of the head to its base, is but two-thirds of what would flow out of a slit of the same dimensions were it horizontal at the level of the base.

11. A *circular* pipe of the same area as a *square*, *triangular*, or *irregular* one, will discharge *more* water in a given time.

12. The greater the length of the discharging pipe, the less the discharge, unless the pipe be perpendicular.

13. A pipe that is inclined will discharge more water in a given time than a horizontal pipe of the same dimensions.

14. The friction of a fluid is greater in small than in large pipes, when equal quantities are discharged.

15. In perpendicular pipes, the discharge being governed by the law of gravitation, the greater the length of the pipe, the greater the discharge.

16. When a prismatic vessel empties itself through an aperture, twice the quantity would be discharged in the same time if it were kept full.

17. In a stream, sluice, or ditch, the velocity is the greatest at the surface and in the middle of the current.

18. The *time* occupied by a given quantity of water passing through pipes or sewers of equal apertures and lengths, and with equal falls, is in the following proportions, viz.: In a straight line, as 90; in a regular curve, as 100; and in passing a right angle, as 140.

To find the velocity of a stream issuing from a head of water.

Rule.—Multiply the height of the head in feet by 64.33, and the square root of the product will be the velocity in feet per second.

Example.—What is the velocity of a stream projected through an opening by a head of 12 feet?

SOLUTION.—$12 \times 64.33 = 771.96$, the square root of which is 27.780 feet per second. *Ans.*

To find the head, the velocity being given.

RULE.—Square the velocity and divide it by 64.33, and the quotient will be the head in feet.

EXAMPLE.—What is the head of water that projects a stream 27.780 feet per second?

SOLUTION.—$27.780^2 = 771.96 \div 64.33 = 12$ feet. *Ans.*

NOTE.—In the above results no allowance is made for friction, which should be made in order to ascertain the practical results. The friction of water passing out of orifices, and not through pipes, sluices, or sewers, is, however, very small.

To find the quantity of water that will issue from an opening, the dimensions of the opening and the head being given.

RULE.—Find the velocity of the jet or stream by the foregoing rule, and multiply it by the area of the orifice in feet, and the product will be the number of cubic feet per second the orifice will discharge.

EXAMPLE.—How much water will an orifice of an area of 2 square feet discharge per second under a head of 12 feet?

SOLUTION.—$12 \times 64.33 = 771.96$, the square root of which is 27.780 feet velocity; then, 27.780×2 feet, area, $= 55\frac{7}{25}$ cubic feet per second. *Ans.*

To find the velocity of currents in drains, ditches, sluices, brooks, or rivers.

Rule.—Find the velocity of the surface of the current in the middle of the stream by taking the number of inches a floating body passes over it in one second.

This, for all ordinary practical purposes, will be sufficient. But to find the *mean* or *average* velocity, take the square root of the velocity so found, double it, and deduct it from the velocity at the top, and add one to the remainder, and the result will be the velocity at the bottom. Add the top and bottom velocities, and divide them by two for the mean velocity.

Example.—What is the mean velocity of a current, the velocity of which at the surface, in the middle of the stream, is 36 inches per second?

Solution.— $\sqrt{36}=6\times 2=12-36=24+1=25$, velocity at bottom; then, 36+25=61÷2=30.5 inches per second, mean velocity. *Ans.*

To find the volume of water discharged by drains, sluices, brooks, &c., of given dimensions, in a given time.

RULE.—Multiply the velocity of the current per second in feet, by the area of the transverse section of the drain or sluice, in feet, and the product will be the quantity discharged per second, in cubic feet.

EXAMPLE.—What volume of water will a drain 2 feet wide and 3 feet deep discharge in one hour, the mean velocity of the current being 30 inches per second?

SOLUTION.—2×3=6 sq. ft., area of section × 2½ ft., velocity, =15 cubic feet discharged per second; then, 15× 3600 seconds (one hour)=54,000 cubic feet per hour. *Ans.*

NOTE.—The standard gallon contains 231 cubic inches, and a cubic foot contains 1728 cubic inches. Accordingly, a cubic foot of water contains 7.476 standard gallons. Hence, if we multiply the number of cubic feet by 7.476, it will give the number of gallons. For instance, the drain in the above example discharges 54,000 cubic feet per hour, which, multiplied by 7.476, gives 403,704 gallons discharged per hour.

To find the velocity of water running through pipes.

RULE.—Multiply the height of the head in feet by 2500; divide this product by a divisor obtained as follows: Divide 13.88 by the diameter of the pipe in inches, and multiply the quotient by the length of the pipe in feet, and the result will be the divisor aforesaid. Divide the first product by this sum, and the square root of the quotient will be the velocity in feet per second of the current in the pipe.

Example.—What is the velocity of water in a pipe 5 inches diameter and 100 feet long, and under a head of 2 feet?

Solution.—$13.88 \div 5 = 2.776 \times 100 = 277.6$ and $2500 \times 2 = 5000$; then, $5000 \div 277.6 = 18$, the sq. root of which is 4.24 feet. *Ans.*

To find the quantity of water discharged through pipes.

Rule.—Multiply the velocity of the current per second in feet by the area of the transverse section of the pipe in feet, and the product will be the quantity discharged in cubic feet per second.

Example.—What quantity of water will a pipe 6 inches diameter and 100 feet long discharge per hour under a head of 2 feet?

Solution.—By the preceding rule, find the velocity of the current in the pipe, thus: 2500×2 feet, head, $= 5000$, $13.88 \div 6$ inches, the diameter of the pipe, $= 2.313 \times 100$ feet, length of the pipe, $= 231.3$, divisor; $5000 \div 231.3 = 24.34$, the square root of which is 4.80 feet, velocity per second. Then, $4.80 \times .1963$ square feet, area of pipe, $=$

.942 cubic feet discharged per second. $.942 \times 3600$ seconds (one hour)=3391 cubic ft. discharged per hour. *Ans.*

To find the pressure of a fluid on the bottom of a vessel, cistern, or reservoir

RULE.—Multiply the area of the base in square feet by the height of the fluid in feet, and their product by the weight of a cubic foot of the fluid.

EXAMPLE.—What is the pressure on the bottom of a cistern 10 feet in diameter and 8 feet deep, filled with water?

SOLUTION.—78.54, area of bottom, $\times 8 = 628.32 \times 62\frac{1}{2}$ lbs., the weight of a cubic foot of water, =39.370 lbs. *Ans.*

To find the pressure on the side of a vessel.

RULE.—Multiply the area of the side in feet by half its depth in feet, and that by the lbs. per cubic foot of the fluid.

EXAMPLE.—What is the pressure upon the sloping side of a pond 10 feet square by 8 feet deep?

SOLUTION.—$10^2 = 100 \times 4$, half the depth, $= 400 \times 62\frac{1}{2}$ lbs., the weight of a cubic foot of water, =25000 lbs. *Ans.*

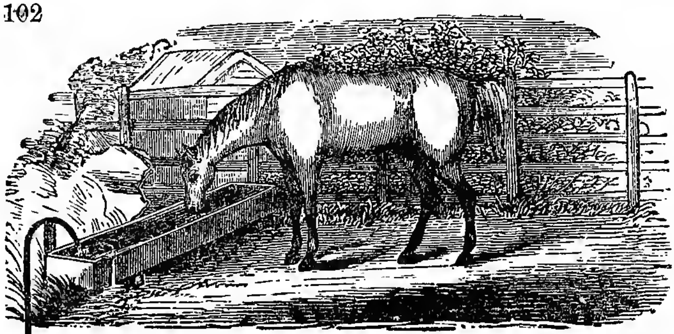
NOTE.—It is proper to remark that all of these rules, while they are theoretically correct, do not pretend to embrace a variety of circumstances which affect the flow of water through apertures, and which should be taken into consideration in all cases. These circumstances cannot be measured by rules, and the just estimate of their influence must depend on experience.

1. Water will flow more rapidly from an aperture in a vessel if a funnel-shaped tun or a rapidly widening trough be attached to it on the outside. This prevents, so to speak, the intercrossing of the currents as they flow over the sides of the aperture; instead of obstructing itself, by reason of its tendency to cross the centre of the opening, the water follows the sides of the funnel or trough, and allows the full area of the opening to discharge freely.

2. The ease with which a given quantity of water can be made to pass through a pipe depends (other things being equal) upon the proportion between the area of the opening and st circumference—the latter being a source of friction. (See Nos. 14 and 11 above.)

3. The ease of the flow depends on the perfect *uniformity* of the channel. A lump or any other inequality in the side of a pipe will disturb the current and cause the water to obstruct itself. Perfect *form* is more important than a *smooth surface.*

4. The same principle operates in the case of deflections from a straight line. If the water is turned out of its course the evenness of the flow is disturbed, and it becomes more difficult (see No. 18 above). The influence of a "regular curve" is in proportion to its radius; more water will flow through a pipe which turns in a large circle than in one which turns more abruptly.



This cut is intended to illustrate the use of the Hydraulic Ram; representing one operated by the water, from a spring near which it is located, and forcing the water through suitable leading and discharge pipe, to a considerable elevation (either perpendicular or upon an inclined plane) to a trough, which may be placed in any convenient locality for watering farm stock of every description,—affording a constant supply of fresh water the year round. It may also be used to supply a cistern or a water-tank in the house.

THE HYDRAULIC RAM.

The *hydraulic ram* is a machine for forcing a portion of a brook or stream to any reqnired elevation and distance, when the requisite head or pressure can be obtained.

Wherever a large spring or a limited but constant stream is at hand, by which a fall of four or five feet may be produced, by building a dam or otherwise, a portion of the water of such spring or stream may be raised to a perpendicular height of more than 100 feet by its own power, through the agency of the water-ram. Thus, a stream in a deep valley, or a rivulet or brook situated some distance below a point where it is desired to have a cistern or reservoir, may be made to raise a part of its water by one of these machines. From such a cistern or reservoir the water may afterwards be conveyed to any part of the premises below it, and applied for the purpose of irrigation, watering of stock, manufactories, or domestic or ornamental use.

The power of the ram, and the height to which it will raise the water, as also the quantity raised, are in proportion to the volume of the stream and the head or fall obtained.

The ram is applicable where no more than 18 inches fall can be obtained.

The *distance* which the water has to be conveyed, and the consequent length of pipe, have also a bearing upon the quantity raised and its elevation, as the larger the pipe through which the water has to be forced, the greater the friction to be overcome, and the more the power consumed in the operation.

The ram can be applied to convey water a distance of from 100 to 200 rods, and to elevations of from 100 to 200 feet.

A fall of 10 feet from the spring or brook to the ram is sufficient to force the water to any elevation not over 150 feet above the ram, and in distance not over 150 rods from it.

Although the same fall will raise water to a much greater elevation, and force it to a greater distance, yet the quantity will *diminish* as the height and distance are increased.

When a sufficient quantity of water is raised by an adequate fall the fall should not be increased, as by so doing the strain upon the ram is unnecessarily increased, and its durability lessened.

The *proportion* which the height to which the water is raised, and the quantity raised, bear to the fall and to the volume of the spring or stream, is about five times the height of the fall, and $\frac{1}{7}$ of the volume of the stream forced a distance of 50 rods—allowing for the friction in both the supply and discharging pipes.

Thus, if the ram be placed under a fall of 5 feet, for every 7 gallons drawn from the spring, 1 gallon may be raised 25 feet, or ½ a gallon 50 feet, and forced a distance of 50 rods. If the fall be 10 feet, it will raise one gallon 50 feet, or ½ a gallon 100 feet, for every 7 gallons discharged by the stream. If the fall be 10 feet, and the *volume of the stream be doubled*, it will raise 1 gallon 100 feet, and so on in the same ratio.

The pipe leading from the spring or head of the fall to the ram is called the *supply pipe*.

The pipe leading from the ram to the reservoir or cistern is called the *discharging pipe*.

The shorter and straighter the supply pipe, the better. Hence, unless the supply pipe is laid to the head of a spring, it is better to dam the stream at the head of its greatest fall, and after inserting the supply pipe at the base of the dam, let it follow the depression of the bed of the stream to the ram at the lowest point.

The shorter and straighter the discharging pipe the better; there is less friction to be overcome.

Should it be necessary to curve either pipe, let the *radius* of the curve be as large as possible.

To ascertain the quantity of water and the height to which it may be elevated by a given fall and volume of water—discharging pipe not over 50 *rods.*

Rule.—Find, by means of a common level, the fall of your spring or stream; then find the quantity of water it discharges per minute or hour, by means of the rule given for that purpose on page 98; then multiply the height of the fall by 5, for the elevation, and divide the number of gallons discharged by the stream by 7, for the quantity of water raised.

EXAMPLE.—Given, a spring with a fall of 8 feet, discharging 28 gallons per minute. How high and how much water will it raise per minute by means of a ram—discharging pipe not exceeding 50 rods?

SOLUTION.—$8 \times 5 = 40$ feet elevation. $28 \div 7 = 4$ gals. per minute. *Ans.*

NOTE.—In the same ratio, it will raise 2 gallons 80 feet per minute, or 1 gallon 160 feet per minute, and so on.

The following working results of water rams now in actual use, will enable the inquirer to ascertain the elevating capacity of springs, with various falls and volume of water. The rams used are "Rumsey & Co.'s Premium Hydraulic Rams," Seneca Falls, N. Y.

1.—Fall from surface of water in spring to ram.	4 feet.
Length of supply pipe, inside diameter 1 inch.	60 "
Volume of water discharged by spring in 10 minutes.	25 gallons.
Length of discharging pipe, inner diameter ⅜ inch, curved in three places to a semicircle.	190 feet.
Elevation of discharging pipe from ram to cistern.	19 "
Discharged every ten minutes.	3½ gallons.

2.—Fall from surface of water in spring to ram.	10 feet.
Length of supply pipe, inside diameter 1½ inches.	40 "
Volume of water discharged by spring per minute.	20 gallons.
Length of discharging pipe, ½ inch inside diameter.	50 rods.
Elevation of discharging pipe from ram to cistern.	85 feet.
Discharged per minute.	2½ gallons.

3.—Fall from surface of water in spring to ram.............. 3½ feet.
Length of supply pipe, inside diameter 1¼ inches............ 30 "
Volume of water discharged by spring...................... not given.
Length of discharging pipe inside diameter ½ inch.......... 30 rods.
Elevation of discharging pipe from ram to cistern........... 35 feet.
Discharged a constant stream ½ inch diameter.

4.—Fall from surface of water in spring.................... 12 feet.
Length of supply pipe, inside diameter 1½ inches............ 32 "
Volume of water discharged by spring...................... not given.
Length of discharging pipe, inside diameter ½ inch.......... 14 rods.
Elevation of discharging pipe from ram to cistern at barn.... 35 feet.
Discharged a constant stream ½ inch diameter, at barn, affording more than a supply for 52 head of cattle.

5.—Fall from surface of water in spring to ram.............. 9 feet.
Length of supply pipe, inside diameter one inch............. 50 "
Volume of water discharged by spring...................... not given.
Length of discharging pipe, inside diameter ½ inch........... 100 feet.
Elevation of discharging pipe from ram to cistern............ 35 "
Discharges a constant stream, ½ inch diameter, into a cistern at house and after supplying water for the domestic use of a large family, passes off to the cattle yard 20 rods further, affording an abundant supply for a large herd of cattle.

6.—Fall from surface of water in spring to ram............. 8 feet.
Length of supply pipe, inside diameter 1½ inches............ not given.
Volume of water discharged by spring...................... "
Length of discharging pipe, ½ inch inside diameter.......... 70 rods.
Elevation of discharging pipe from ram to cistern........... 80 feet.
Delivers a good supply of running water at house and barn, sufficient for all necessary purposes.

7.—Fall of water from surface of spring to ram............. 10 feet.
Length of supply pipe, inside diameter 1½ inches............ not given.
Volume of water discharged by spring...................... "
Length of discharging pipe, ½ inch inside diameter.......... 76 rods.
Elevation of discharging pipe from ram to cistern............ 110 feet.
Delivers a constant stream of ½ inch diameter.

8.—Fall from surface of spring to ram..................... 6½ feet.
Length of supply pipe, inside diameter 1½ inches............ 60 rods.
Elevation of discharging pipe from ram to cistern........... 60 feet.
Discharges sufficient water in barn yard to supply 30 head of cattle.

9.—Fall from surface of spring to ram..................... 9 feet.
Size of supply pipe, inside diameter 2 inches, length......... not given.
Length of discharging pipe, inside diameter ⅝ inch........... 150 rods.
Elevation of discharging pipe from ram to cistern............ 130 feet.
Delivers an abundant supply of water for house, barn, barn-yard and hog-pen.

10.—Fall from surface of dam to ram........................	7 feet.
Length and size of supply pipe..............................	not given.
Volume of water discharged by stream.......	"
Length of discharging pipe, (size not given).................	126 rods.
Elevation of discharging pipe from ram to cistern............	75 feet.
Discharges 25 barrels of water in 24 hours.	
11.—Fall from spring to ram................................	11 feet.
Size of supply pipe, 2 inches calibre; length................	42 "
Length of discharging pipe, ½ inch calibre....................	75 rods.
Elevation of discharging pipe from ram to cistern............	98 feet.
Discharges over 30 barrels of water per day.	

NOTE.—The size, strength, and weight of the supply and discharging pipes must be in proportion to the head or pressure on them. They are proportioned and adjusted to the capacity of the ram by the manufacturer, and are generally sold with the machine.

When a very large supply of water is required for manufacturing or other purposes, and a stream of sufficient volume and fall is obtained, it is better to set two or three rams of a smaller size, all playing into one discharging pipe, than to set one large ram. If one ram becomes disabled, the others supply the demand.

Should the fall and volume of one stream or spring not supply enough water, and at the required elevation, and there be other springs near by, set a ram in each, all meeting in one discharging pipe. Their combined power will increase the elevation and the quantity raised.

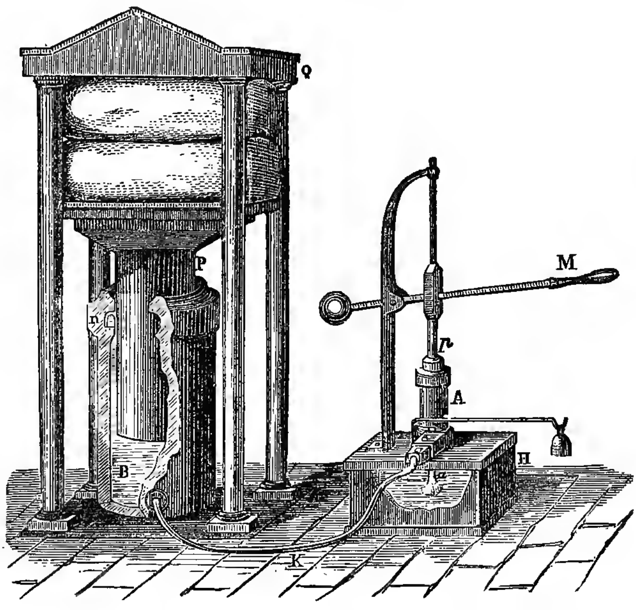
The pipes can be so laid, and the ram so set, as to protect them from the frost during the winter.

The fall of one spring or stream may be used to raise the water of another and better spring or stream, whose own fall is not sufficient.

Mr. H. L. Emery, of Albany, in a communication to the *Country Gentleman*, says: "The result of a water ram is calculated upon the principle that a pound of force will raise a pound of water an equal height, and a less quantity to a greater height, which height is limited only by the strength of the pipes themselves.

"To enable any one to select the size ram it is necessary to compute the elevation to be overcome, and the greatest amount of fall which can be conveniently obtained, and divide the first by the last, and the quotient will be the proportion of the water (passing through the drive-pipe) which will be raised; first, however, deducting for waste of power and friction say $\frac{1}{4}$ of the amount; thus, with ten feet fall and one hundred feet elevation, one-tenth of the water would be raised, if there were no friction or loss; but deducting, say one-quarter for loss, and $7\frac{1}{2}$ gallons for each 100 gallons would be raised, all the balance of the water being required or wasted to accomplish this result."

THE HYDRAULIC PRESS.



The Hydraulic or Hydrostatic Press is a machine by which a small force may be made to exert a great pressure. Its construction may be understood by the above cut. Two metallic cylinders, A and B, of different sizes, are joined together by a tube K. In the small cylinder there is a piston *p* which can be moved up and down by the handle

M. In the large cylinder there is also a piston P, having at its upper end a large iron plate, which moves freely up and down in a strong frame-work Q. Between the iron plate and the top of this framework the body to be pressed is placed. Now, when the small piston is raised, the cylinder A is filled with water drawn from the reservoir H, below, and when it is pushed down this water is forced into the large cylinder through the pipe K. There is a valve in this tube which prevents the water from returning, so that each stroke of the small piston pushes an additional quantity of water into the large cylinder. By this means the large piston is pushed up against the body to be pressed. To calculate the pressure exerted by the large piston we must remember that the force acting upon the piston in A, will be exerted upon every equal amount of surface in B. To illustrate this: suppose the area of the large piston to be 10 times the area of the small one; then one pound at A will produce a pressure of ten pounds at P. The handle M increases the advantage still more, according to the principle of the lever to be explained in a future chapter. By increasing the size of the large cylinder, and diminishing the size of the small one, the pressure exerted by a given power will be increased proportionately. The weight of a man's hand might thus be made to lift a ship with all its cargo. The only limit to the increase of power would be the strength of the material of which the machine is made.

WEIGHT OF LEAD PIPE.

TABLE, *showing the weight of lead pipe per yard, from ¼ to 4½ inches diameter.*

Diameter.	Weight in lbs.	oz.	Diameter.	Weight in lbs.	oz.
¼ inch medium	3		1½ inch extra light	9	
" " strong	4		" " light	13	
½ " light	3		" " medium	15	8
" " medium	4		" " strong	19	
" " strong	5		1¾ " medium	16	
" " extra strong	6	6	" " strong	20	
⅝ " light	5		2 " light	16	12
" " medium	6	6	" " medium	20	
" " strong	7	8	" " strong	23	
" " extra strong	8	4	2½ " light	25	
¾ " " light	5		" " medium	30	
" " light	6	4	" " strong	35	
" " medium	8		3 " light	30	
" " strong	9	12	" " medium	35	
" " extra strong	10	8	" " strong	44	
1 " " light	6	14	3½ " medium	45	
" " light	8	5	" " strong	54	
" " medium	10	5	" " extra strong	70	
" " strong	12	4	4 " waste, light	15	14
1¼ " extra light	8	5	" " " medium	21	
" " light	9	12	" " " strong	26	
" " medium	11		4½ " " light	17	4
" " strong	12	8	" " " medium	24	
" " extra strong	14	10	" " " strong	29	

Very light pipe.

¼ inch	1 lb.	¾ inch	3 lbs. 6 oz.
⅜ "	1½ "	1 "	5 " 10 "
½ "	2 "	1¼ "	6 " 14 "
⅝ "	2½ "		

NOTE.—Should the pipe be sold by the pound, multiply the price per lb. by the weight per yard in the above table, and it will give the price per yard.

FUEL.

The following table, abridged from Browne's *Sylva Americana*, will be found valuable to housekeepers in aiding them to form an estimate of the comparative value of fire woods in a *seasoned state*, or when burnt to charcoal.

TABLE, *showing the Comparative Values of Fire Woods.*

WOODS.	Specific Gravity of dry Woods.	Pounds dry Wood in one Cord.	Specific Gravity of dry Coals.	Pounds Charcoal in one bushel.	Pounds Charcoal from one cord of dry Wood.	Bushels Charcoal from one cord of dry Wood.	Value as compared with shellb'rk Hickory.
Shellbark Hickory, ...	1.000	4469	.625	82.89	1172	36	100
Common Walnut, ...	.949	4241	.637	33.52	1070	32	95
White Oak, ...	.855	3821	.401	21.10	826	39	81
Thick Shellbark Hickory, .	.829	3705	.509	26.78	848	32	81
White Ash, ...	.722	3450	.547	28.78	88[illegible]	31	77
Scrub Oak, ...	.747	3339	.392	20.63	774	38	73
Witch Hazel, ...	.784	3505	.368	19.36	750	39	72
Apple Tree, ...	.697	3115	.445	2[illegible].41	779	33	70
Red Oak, ...	.728	3255	.400	21.05	630	30	69
Black Gum, ...	.703	3142	.400	21.05	696	83	67
Black Walnut, ...	.681	3044	.418	22.00	6[illegible]7	31	65
White Beech, ...	.724	3233	.518	27.26	635	23	65
Black Birch, ...	.697	3115	.428	22.52	604	27	63
Yellow Oak, ...	.653	2919	.295	15.52	631	41	60
Sugar Maple, ...	.644	2878	.431	22.68	617	27	60
Sassafras, ...	.618	2762	.427	22.47	624	28	59
White Elm, ...	.580	2592	.357	18.79	644	34	58
Holly, ...	.602	2691	.374	19.68	613	31	57
Wild Cherry, ...	.597	2668	.411	21.63	579	27	55
Yellow Pine, ...	.551	2463	.333	17.52	585	[illegible]3	54
Sycamore, or Buttonwood,	.535	2391	.374	19.68	564	29	52
Chestnut, ...	.522	2333	.379	19.94	590	30	52
Spanish Oak, ...	.548	2449	.362	19.05	562	30	52
Poplar, ...	.563	2516	.383	20.15	549	27	52
Butternut, ...	.567	2534	.237	12.47	527	42	51
White Birch, ...	.530	2369	.364	19.15	450	24	48
Jersey Pine, ...	.478	2137	.385	20.26	532	26	48
Pitch Pine, ...	.426	1904	.298	15.68	510	33	43
White Pine, ...	.418	1868	.293	15.42	455	30	42
Lombardy Poplar, ...	.397	1774	.245	12.89	444	34	40

Note.—It will be remarked that shellbark hickory is made the *standard* in the above table, not only of the fuel but also of the specific gravity, the value and specific gravity of the other woods being determined by the proportion they severally bear to this standard. The table has a further use, namely, to determine the price that should be paid per cord for other woods, taking the price paid for shellbark hickory as the standard. For instance, should shellbark be selling for $6.00 per cord, white oak is worth $4.86; for, as 100, the value of shellbark, : $6.00, its price, :: 81, the value of white oak, : $4.86, its price; and other kinds in the same proportion.

A cord of wood is 128 cubic feet; the sticks or billets are cut 4 feet long and piled 4 feet high and 4 feet wide; 8 feet in length making a cord.

The wood-cutter has a measure of two feet marked on his axe handle with which he measures the length of each stick, making due allowance for the carf, or the bevel of the cut. All fuel should, however, be sold by weight.

When the weights of different woods are equal, that which contains the most hydrogen will, during combustion, give out the greatest amount of heat. Hence, pine is preferable to oak, and bituminous to anthracite coal. When wood is used as fuel it should be thoroughly dried, as in its green and ordinary state it contains 25 per cent. of water; the heat to evaporate which is necessarily lost. To kiln-dry it adds 12 per cent. to its value over seasoned wood.

Coal Mining in Pennsylvania.

TABLE, *showing the weights per cubic foot of the different kinds of Coal.*

Designation.	Weight in lbs.	Designation.	Weight in lbs.
Anthracite,	50 to 55	Western, (bitum.)	47
Bituminous,	45 to 55	English, "	50
Cumberland,	53	Charcoal, (hard wood)	18½
Virginia, (bitum.)	49	do. (soft or pine wood)	18

NOTE.—Soft coals are usually purchased at the rate of 28 bushels of 5 pecks each, to a ton of 43.56 cubic feet. Anthracite, 20 bushels to the ton

To prepare charcoal.

Charcoal is prepared by clearing off the top soil from a circular space of the required dimensions, and piling billets of wood in it into a pyramidal heap, with several spiracles or flues formed through the pile. Chips and brushwood are put into those below, and the whole is so constructed as to kindle through in a very short time. It must then be covered all over with clay or earth beaten close, leaving openings at all the spiracles or flues. The pile is then ignited, and carefully watched and kept from bursting into a flame, by instantly closing the flues should such happen. Whenever the white watery smoke issuing from the flues is observed to be succeeded by a thin, blue, and transparent smoke, the holes must be immediately stopped; this being the indication that all the watery vapor is gone, and the burning of the true coaly matter commencing. Thus a strong red heat is raised throughout the whole mass, and all the volatile matters are dissipated by it, and nothing now remains but the charcoal. The holes being all stopped in succession as this change of the smoke is observed, the fire goes out for want of air. The pile is now allowed to cool, which requires many days, for charcoal being a very bad conductor of heat, the pile long remains red hot in the centre, and if opened in this state would instantly burn with great fury. Even when it is opened, the heat retained by some of the larger pieces often ignites it, to guard against which water should be provided to instantly extinguish it when observed.

PROPERTIES OF CHARCOAL.

Although charcoal is so combustible, it is, in some respects, a very unchangeable substance, resisting the action of a great variety of other substances upon it. Hence posts are often charred before being put into the ground. Grain has been found in the excavations at Herculaneum, which was charred at the time of the destruction of that city, eighteen hundred years ago, and yet the shape is perfectly preserved, so that you can distinguish between the different kinds of grain. While charcoal is itself so unchangeable, it preserves other substances from change. Hence meat and vegetables are packed in charcoal for long voyages, and the water is kept in casks which are charred on the inside. Tainted meat can be made sweet by being covered with it. Foul and stagnant water can be deprived of its bad taste by being filtered through it. Charcoal is a great decolorizer. Ale and porter filtered through it are deprived of their color, and sugar-refiners decolorize their brown syrups by means of charcoal, and thus make white sugar. Animal charcoal, or bone-black, is the best for such purposes, although only one-tenth of it is really charcoal, the other nine-tenths being the mineral portion of the bone.

Charcoal will absorb, of some gases, from eighty to ninety times its own bulk. As every point of its surface is a point of attraction, it is supposed to account for the enormous accumulation of gases in the spaces of the charcoal. But this accounts for it only in part. There must be some peculiar power in the charcoal to change, in some way, the condition of a gas of which it absorbs ninety times its own bulk.—*Hooker.*

NOTES.—The best quality of charcoal is made from oak, maple, beech, and chestnut.

Wood will furnish, when properly charred, about 20 per cent. of coal.

A bushel of coal from hard wood weighs 30 lbs.

A bushel of coal from pine weighs 29 lbs.

TABLE, *showing the number of parts of charcoal afforded by* 100 *parts of different kinds of wood.*

Woods.		Parts charcoal.	Color.
Lignum Vitæ	afforded.............	26.8	Grayish.
Mahogany	"	25.4	Brown.
Laburnum	"	24.5	Velvet black.
Chestnut	"	23.2	Glossy black.
Oak	"	22.6	Black.
Black beech	"	21.4	Fine black.
Holly	"	19.9	Dull black.
Sycamore	"	19.7	Fine black.
Walnut	"	20.6	Dull black.
Beech	"	19.9	Dull black.
Maple	"	19.9	Dull black.
Norway Pine	"	19.2	Shining black.
Elm	"	19.2	Fine black.
Sallow	"	18.4	Velvet black.
Ash	"	17.9	Shining black.
Birch	"	17.4	Velvet black.
Scottish Pine	"	16.4	Brownish.

COKE.

Sixty bushels of Newcastle lump coal, will make 92 bushels of coke.

Sixty bushels of Newcastle slack, or fine coal, will make 85 bushels of coke.

Sixty bushels Pictou or Virginia Coal, will made 75 bushels coke of an inferior quality compared with the above.

A bushel of the best coke weighs 32 lbs.

The production of coke by weight is about $\frac{2}{3}$ that of coal.

Coal furnishes 60 to 70 per cent. of coke by weight.

1 lb. of coke will evaporate in a common locomotive boiler $7\frac{1}{8}$ lbs. of water at 212° into steam.

TABLE, *showing the weights, evaporative powers per weight, bulk and character of Fuel.*

DESIGNATION.	Specific Gravity.	Weight per cubic foot.	Lbs. of steam from water at 212° by 1lb. fuel.	Lbs. of steam from water at 212° by 1 cubic ft. of fuel.	Weight of clinker from 100 lbs. of coal.	No of cubic feet required to stow a ton.
Bituminous.						
Cumberland max.,	1.313	52.92	10.7	573.3	2.13	42.3
" min,	1.337	54.29	9.44	532.3	4.53	41.2
Blossburgh,	1.324	53.05	9.72	522.6	3.40	42.2
Midlothian screened,	1.283	45.72	8.94	438.4	3.33	49.
" average,	1.294	54.04	8.29	461.6	8.82	41.4
Newcastle,	1.257	50.82	8.66	453.9	3.14	44
Pictou	1.318	49.25	8.41	478.7	6.13	45.
Pittsburgh,	1.252	46.81	8.20	384.1	.94	47.8
Sydney,	1.338	47.44	7.99	386.1	2.25	47.2
Liverpool	1.262	47.88	7.84	411.2	1.86	46.7
Clover Hill	1.285	45.49	7.67	359.3	3.86	49.2
Cannelton, Ia.,	1.273	47.65	7.34	360.	1.64	47.
Scotch,	1.519	51.09	6.95	369.1	5.63	48.8
Anthracite.						
Peach Mountain,	1.464	53.79	10.11	581.3	3.03	41.6
Forest Improvement,	1.477	53.66	0.06	577.3	.81	41.7
Beaver Meadows, No. 5,	1.554	56.19	9.88	572.9	.60	39.8
Lackawanna	1.421	48.89	9.79	493.	1.24	45.8
Beaver Meadows, No. 3,	1.610	54.93	9.21	526.5	1.01	40.7
Lehigh,	1.590	55.32	8.93	515.4	1.08	40.5
Coke.						
Natural Virginia,	1.323	46.64	8.47	407.9	5.31	48.3
Midlothian,		32.70	8.63	282.5	10.51	68.5
Cumberland,		31.57	8.99	284.	3.55	70.9
Wood.						
Dry Pine wood,		20.01	4.69	98.6		106.6

Prof. W R. Johnson.

N. B.—The above are the extreme effects; for practical use let a deduction of $\frac{1}{8}$ be made from the above.

Combustible matter of fuel.

The quantity of combustible matter of fuel, if the weight and other circumstances be equal, may be learnt from the ashes, or residuum, left after the combustion. For example, good Newcastle coal contains a greater portion of combustible matter than Nova Scotia coal, and leaves behind a smaller amount of earthy and incombustible substance. The heating power, and consequent value, of different kinds of fuel, is affected by this circumstance, though by no means dependent on it. The fitness of fuel for various purposes is furthermore affected by the facility with which it gives off a part of its combustible matter in the form of vapor or gas, which, being burnt in that state, produces *flame.* For example, the bituminous coals abound in volatile matter, which, when ignited, supports a powerful blaze. On the other hand, the Lehigh and Rhode Island coals are destitute of bitumen, and yield but little flame. It is from similar causes that dry pine wood produces a powerful blaze, while its charcoal yields comparatively little. A blaze is of great service where heat is required to be applied to an extensive surface, as in reverberating furnaces, ovens, glass-houses, &c. But when an equable, condensed, or lasting fire is wanted, the more solid fuels, which blaze less, are to be preferred.

TABLE, *showing the heating power of different combustibles.*

Designation.	Lbs. of water heated 1° by 1 lb. of substance.	Designation.	Lbs. of water heated 1° by 1 lb. of substance.
Alcohol	11,000	Coal, Newcastle	9,230
Olive Oil	14,500	" Welsh	11,840
Beeswax	14,000	" Anthracite	9,560
Tallow	15,000	" Cannel	9,000
Oak, seasoned	4,600	Coke	9,110
" kiln-dried	5,960	Peat	3,250
Pine, seasoned	5,466		

TABLE, *showing the effects of heat upon certain bodies.*

Designation.	Fahrenheit.	Designation.	Fahrenheit.
Gold melts	1983°	Tin melts	421°
Silver "	1850°	Water boils	212°
Copper "	2160°	Alcohol "	175°
Brass "	1900°	Ether	93°
Iron, red hot in daylight	1077°	Heat of human blood	98°
" " twilight	884°	Water freezes	32°
Common fire	790°	Strong wine freezes	20°
Zinc melts	740°	Brandy "	7°
Quicksilver boils	630°	Mercury "	—39°
Linseed Oil "	600°	Greatest cold ever produced*	—220°
Lead melts	594°	Snow and salt, equal parts	0°
Bismuth melts	476°	Acetous fermentation begins	78°
Tin and Bismuth, equal parts, melts	283°	" " ends	88°
		Phosphorus burns	68°

TABLE, *showing the relative value of the following fuels by weight.*

Designation.	Value.	Designation.	Value.
Seasoned oak	125	Charcoal	285
Oak, kiln-dried	140	Peat	115
Hickory	137	Welsh coal	312
White pine	137	Newcastle "	309
Yellow pine	145	Anthracite "	250
Good Coke	285		

* The lowest temperature hitherto attained, —220°, is produced by evaporating in vacuo a mixture of solid (condensed) protoxide of nitrogen, carbonic acid, and bisulphide of carbon.

TABLE, *showing the number of gallons of water which may be lifted to various heights by the consumption of* 112 *lbs. of coal, the pumping apparatus being good, and adapted to the power of the steam engine.*

Height.	Gallons.	Height.	Gallons.
1 foot	1,600,000	9 feet	177,777
2 "	800,000	10 "	160,000
3 "	533,333	11 "	145,454
4 "	400,000	12 "	133,333
5 "	320,000	13 "	123,076
6 "	266,666	14 "	114,444
7 "	228,571	15 "	106,666
8 "	200,000	16 "	100,000

NOTES.—The evaporative power of 1 lb. of *bituminous* coal applied to a steam boiler, is from 6 to 9 lbs. fresh water in the boiler, under a pressure of 30 lbs. to the square inch, evaporated into steam. Cumberland coal being the strongest, and Scotch coal the weakest.

The evaporative power of *anthracite* coal, aided by a blast, is from 7½ to 9½ lbs. of fresh water evaporated into steam for 1 lb. of coal.

In practical evaporating power 2½ to 2¾ lbs. of wood is equivalent to 1 lb. of bituminous or anthracite coal.

One cord of the ordinary seasoned fire-wood is equal in evaporating power to 12 bushels (960 lbs.) of Pittsburgh coal.

One ton of Cumberland coal is equal in evaporating power to 1¼ tons of anthracite coal, and equal to 2.12 cords of dry pine wood.

One ton of anthracite coal is equal to 1¾ cords of dry pine wood.

Each cubic foot of water evaporated in a boiler at the pressure of the atmosphere, will heat 2,000 cubic feet of inclosed air to an average temperatnre of 75°.

Each square foot of surface steam-pipe will warm 200 cubic feet of space.

One pound of anthracite coal in a cupola furnace will melt 5 to 10 lbs. of cast iron.

80 bushels of bituminous coal in an air furnace will melt 10 tons of cast iron.

Small or fine coal produces about ¾ the effect of large coal of the same kind.

TABLE, *showing the price of parts of a cord of wood, at certain rates per cord.*

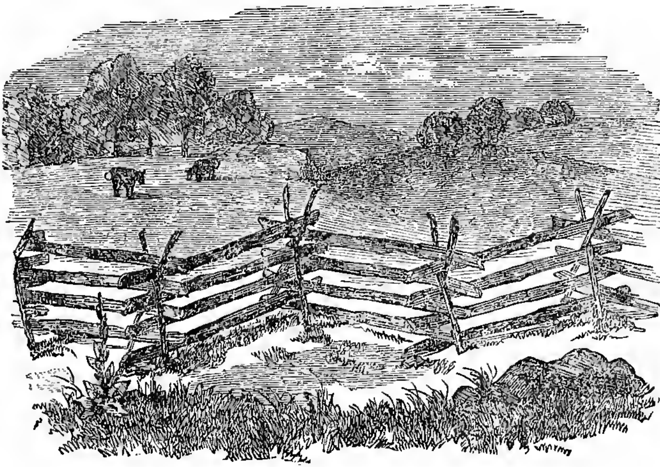
FEET	$1.50	$1.75	$2.00	$2.25	$2.50	$2.75	$3.00	$3.25
1	0 01	0 01	0 01	0 02	0 02	0 02	0 02	0 02
2	0 02	0 02	0 03	0 03	0 04	0 04	0 05	0 05
3	0 03	0 04	0 04	0 05	0 06	0 06	0 07	0 07
4	0 05	0 06	0 06	0 07	0 08	0 09	0 09	0 10
5	0 06	0 07	0 08	0 09	0 10	0 11	0 12	0 13
6	0 07	0 08	0 09	0 11	0 12	0 13	0 14	0 15
7	0 08	0 10	0 11	0 12	0 14	0 15	0 16	0 17
8	0 09	0 11	0 12	0 14	0 16	0 18	0 19	0 20
16	0 19	0 22	0 25	0 28	0 31	0 35	0 37	0 40
24	0 28	0 33	0 37	0 42	0 47	0 52	0 56	0 61
32	0 38	0 44	0 50	0 56	0 63	0 69	0 75	0 81
40	0 47	0 55	0 63	0 70	0 78	0 86	0 94	1 02
48	0 56	0 66	0 75	0 84	0 94	1 03	1 12	1 22
56	0 61	0 77	0 88	0 98	1 09	1 20	1 31	1 42
64	0 75	0 88	1 00	1 13	1 25	1 38	1 50	1 62
72	0 84	0 98	1 13	1 27	1 41	1 55	1 69	1 83
80	0 94	1 09	1 25	1 41	1 56	1 72	1 88	2 03
84	0 98	1 15	1 31	1 48	1 64	1 81	1 97	2 13
88	1 03	1 20	1 38	1 55	1 72	1 89	2 06	2 23
92	1 08	1 26	1 44	1 62	1 80	1 98	2 15	2 33
96	1 13	1 31	1 50	1 69	1 88	2 06	2 25	2 44
104	1 22	1 42	1 63	1 83	2 03	2 23	2 44	2 64
112	1 31	1 53	1 75	1 97	2 19	2 41	2 62	2 84
120	1 41	1 64	1 88	2 11	2 34	2 58	2 81	3 05
128	1 50	1 75	2 00	2 25	2 50	2 75	3 00	3 25

EXPLANATION.—Find the number of feet in the left-hand column of the table; then the price at the top of the page, and trace the line and column until they meet, and you will find the amount in dollars and cents.

EXAMPLE.—If a load of wood contains 98 feet, at two dollars and a half per cord—first find the amount of 96 feet, which is $1.88; and then add the value of 2 feet (4 cents), making $1.92. So of all similar examples.

Should the price per cord exceed the amount in the preceding table, the price of the parts may be found by adding or doubling, as per example, for $3.50 double $1.75; for $3.75 add $2.00 and $1.75; for $4.00 double $2.00; for $5.00 double $2.50, &c.

FENCES.



In the newer portions of the country, where land is cheap and timber abundant, the old-fashioned zig-zag, or "*Virginia worm fence*," still prevails. It does not cost one-third the amount required for good post or board fence. Some are constructed altogether of rails, without any bracing or support at the corners, and are, of course, easily thrown down by cattle and the wind. They are, however, usually braced in one of the following modes:

1. By stakes and riders—either single or double riders.

2. By upright stakes, opposite each other, and placed in the *obtuse* corners, driven into the ground, and tied at the top by a wire or withe.

3. By upright stakes placed in the *acute* corners, driven into the ground, and tied at the top as above described.

4. By wedging one end of a rail into the acute corner, and letting the other end rest on the ground.

5. By placing the riders, or long poles, in a straight line on the top and at the centre of the fence, and then placing upright stakes in each inner corner, between the rider and the fence, the lower end resting on the ground and the other wedged tightly between the top and the rider.

The rails for this species of fence are cut different lengths in different sections of the country, and, indeed, in the same section. Much depends upon the nature of the timber, and much also on the kind of ground on which the fence is to be laid. Some are cut 12 feet, some 14, and some even 16½ feet or 1 rod in length. The usual lengths, however, are 12 and 14 feet.

The rails are laid at different angles; some deflecting 6 feet, some 7, and some 8 feet from a right line. The more they deflect, or in other words, the *crookeder* they are laid, the firmer the fence will be; but more rails will be required and more space occupied. The deflection for a 12 foot rail is usually 6 feet; for a 14 foot rail, 7 feet; and for a rod rail, 8 feet. A foot is generally allowed at each end for the lap.

Some fences are built 5 rails high, some 6, and some 7—the rider making an additional rail high. The height, as well as the spaces between the rails, are mostly regulated by statute in the different States. The majority of these statutes require the fence to be not less than 5 feet high, with interspaces between the rails of not more than 4 inches, to a height of 4 feet.

The number of rails, stakes, and riders required to build a certain amount of fence has hitherto been pretty much guesswork; and often the farmer, before he can finish his fence, has to quit it, and go and split more rails, or gear up and haul a few more loads. It is hoped that the following tables will obviate that necessity, by enabling him to tell within a few rails how many will be required to build a given amount of fence.

TABLE, *showing the number of rails, stakes, and riders required for each* 10 *rods of fence.*

Length of rail.	Deflection from right line	Length of panel	Number of panels	Number of rails for each 10 rods.			Number of stakes.	Number of riders, (single.)
Feet.	Feet.	Feet	Feet	5 rails high.	6 rails high.	7 rails high.		
12	6	8	$20\frac{5}{8}$	103	123	144	42	21
14	7	10	$16\frac{1}{2}$	83	99	116	31	17
$16\frac{1}{2}$	8	12	$13\frac{3}{4}$	69	84	95	28	14

NOTE.—Should the number of rods exceed 10, the requisite number of rails, stakes, and riders can be found by multiplying. For instance, should the length of fence be 100 rods, multiply the above number by 10; should it be 75 rods, multiply the above number by $7\frac{1}{2}$; for 77 rods, multiply by $7\frac{7}{10}$, and so forth.

Post and rail fence.

Post and rail is a more costly fence, but much better, and in the end more economical. There is not such a waste of either timber or land.

The rails are also cut of different lengths; some 10, some 12, some 14, and some 16½ feet, or 1 rod. Formerly, about 6 inches at each end were allowed for the lap, but more recently a foot has been allowed, as the longer the lap the stronger and firmer the fence. They are from 5 to 8 rails high; posts set in the ground from 2 to 3 feet.

TABLE, *showing the number of rails and posts required for each* 10 *rods of post and rail fence.*

Length of rail—feet.	Length of panel—feet	Number of panels.	Number of posts.	Number of rails for each 10 rods.			
				5 rails high	6 rails high.	7 rails high	8 rails high.
10	8	20⅝	21	103	123	144	165
12	10	16½	17	83	99	116	133
14	12	13¾	14	69	84	95	109
16½	14½	11⅓	12	57	69	81	93

NOTE.—Should the length exceed 10 rods, the additional number of posts and rails may be found by multiplying, as directed in the note to the preceding table.

Post and board fence.

Where timber is plenty and saw-mills abound, or where lumber is cheap, post and board fence is economical.

The boards are usually sawed 16 feet long, and the posts set 8 feet apart, 3 feet in the ground.

The fence is usually 5 boards high; the bottom or first board 10 inches wide; the second 8, the third 6, and the fourth and fifth 5 inches wide. They may be wider or narrower, as cost, taste, or use may dictate.

The first, third, and fifth boards are joined on one post, and the second and fourth joined on the next post.

To find the number of feet of boards required for each rod of post and board fence.

RULE.—Add the different widths of the boards, in inches, together, and divide the sum by 12 for the width in feet; then multiply the width by $16\frac{1}{2}$, and the product will be the number of feet, board measure, required for each rod of fence.

EXAMPLE.—Required, the number of feet, board measure, for each rod of fence, 5 boards high, the various widths of the boards being 10, 8, 7, 6 and 5 inches?

SOLUTION.—$10+8+7+6+5=36\div12=3$ ft. $\times16\frac{1}{2}=49\frac{1}{2}$ feet. *Ans.*

To find the number of posts required for a given length of post and board fence.

RULE.—Reduce the number of rods to feet by multiplying by $16\frac{1}{2}$, and divide the product by the number of feet the posts are set apart; the quotient will be the number of posts required.

EXAMPLE.—Required, the number of posts for a post and board fence 160 rods long; posts set 8 feet apart?

SOLUTION.—$160\times16\frac{1}{2}=2640\div8=330$. *Ans.*

HEDGE PLANTS.

The following, for the cultivation of hedges, is the condensed experience of the most successful and practical hedge-growers in the United States, and especially in the West.

Directions for Setting.—During the summer or fall thoroughly manure, plough as deep as possible a strip from five to eight feet wide, leave a dead furrow in the line where the hedge is to be set. In the following spring back furrow to the hedge-line, then harrow down smooth. Stake the ground, and by means of a line make a plain mark, then with a spade placed at right angles across the mark, push the blade in the soil to its full length at an angle of about forty-five degrees. Let an assistant place the plants under the back of the spade on the line of the mark, about one inch below the depth they stood in the nursery, and about eight inches apart. Pack the ground firmly around the plants, and mulch the ground to keep moist. Cultivate until the first of August. Before frost in the fall, back furrow and cover with coarse manure or straw, and in the spring uncover and cultivate as before. Replace all missing or feeble plants with strong ones.

Trimming.—The hedge should not be trimmed until three years old, when one-half or two-thirds should be cut nearly off close to the ground and laid down at an angle of thirty degrees from the ground. Trim once a year in July, and do not allow the hedge to exceed twenty inches broad. The fourth year in the spring, before the buds start, take off about one-half the last year's growth. Leave the lower branches a little longer than the top, and aim to give the hedge some regular uniform shape. The hedge should be allowed to gain from eight to twelve inches annually, until it has reached the desired height.

To Preserve Plants during the Winter.—Cut a trench in a dry piece of ground at an angle of forty-five degrees, place the bundles in the trench, and cover with dirt from a new trench from six to eight inches in front, and so continue until all are trenched. Cover the plants two inches deep, firmly packing the ground around them. After the ground is frozen two inches deep, cover the whole with straw from twelve to eighteen inches; after which cover the whole bed with dirt about a foot thick. Encircle with a ditch so that no water can reach the plants. Plants can also be kept in a cellar, well covered in sand, but be careful not to expose to the sun or dry wind, in setting in the spring.

Setting Evergreens.—Cultivate and set as before, but the ground should not be manured within six months of setting the plants. Chip-dirt or rotten leaves are preferable for a mulch.

Hedge Plants.—Osage Orange.—The Osage Orange stands at the head of the list of hedge plants. It is much planted where fencing timber is scarce, in the latitude of the Middle and Southern States. It is hardy and grows vigorously, and its thorns are absolute proof against the depredations of domestic animals, and even boys retreat from contact with them. It makes a beautiful hedge when properly pruned, but when neglected it gets beyond all control. In the Northern and Eastern States, it is liable to be killed by the frost.

Honey Locust.—This thorny, vigorous, and hardy plant has no superior as a farm hedge. It requires two annual prunings, in June and September, to keep it within control. It flourishes as far north as Canada, and for the Middle and Southern States it yields only to the Osage Orange. It is easily propagated by setting the plants about six inches apart. Some prefer sowing the seed on the line of the proposed hedge.

Buckthorn.—This plant is a native of America, and would be one of the best hedge plants did it not lack a supply of thorns.

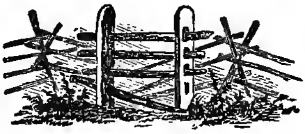
Privit.—This thornless shrub is easily propagated from cuttings, and thickens well when set in a hedge. Its foliage is rich, and in the spring it is decorated with an abundance of beautiful small white flowers. It cannot be successfully cultivated north of the latitude of Philadelphia.

Hawthorn.—The hawthorn, so common in England, does not thrive so well in our climate.

Evergreen Hedges.—Norway Spruce.—A hedge of this beautiful tree should be set about four or five inches apart, and the plants not over four feet high. The side branches should be pruned, and the leaders cut out. Afterwards it should be trimmed the same as other hedges. The soil should be kept rich to insure a vigorous growth.

Arbor Vitæ.—In consequence of the cheapness of the common Arbor Vitæ, for an ornamental hedge, it has superseded all others. Though inferior to the Siberian species, yet it will be a long time before it will yield its place to it. Being hardy and sure to flourish under ordinary treatment, it is a valuable hedge plant.

Hemlock.—The hemlock, when properly pruned, makes a thick and beautiful hedge. With a foliage ever of the richest green, and adapted to all the northern latitudes, as a hedge plant it has no superior if an equal. Although hardy, it is somewhat difficult to transplant. Select a rainy day when the ground is wet, being careful not to expose the roots to the light or air. As soon as planted mulch with coarse manure or chip-dirt.



WIRE FENCES.

Wire fences have this advantage over hedges and other fences: they take up but little space, with no exhaustion of the soil, are not blown about by the wind; are durable, economical, and make a good protection against cattle, sheep, and other animals. For enclosing lawns and gardens, many of the designs offered in market are very desirable and ornamental. For a farm fence, such as any farmer can put up, annealed wire of the size No. 6 or 8* is preferable; for the protection of cattle five wires are sufficient; for sheep and lambs, seven should be used.

In building the fence a post six inches square or larger should be set at each end, and securely braced, from which to stretch the wire; the intervening posts should be set from eight to ten feet apart. Through these holes should be bored with a ¼-inch brace-bit, and at appropriate distances apart, according to the protection required. Instead of putting the wires through the posts, they are often fastened by means of staples made of the same material. In putting up the wires they should be stretched as tightly as possible, care being taken in splicing that they be well secured, which can be best done by means of narrow blacksmith's tongs.

Suitable wire can be bought for 8 or 10 cents per pound, making a fence of six wires cost about 40 cents per rod; this does not include posts and labor of setting.

* The size of wire is graded from No. 1, and upwards. No. 9 is the common telegraph wire.

HUMAN STRENGTH.

The *force* of a single man, unaided by machinery, and working to the best advantage, is equivalent to the raising of 70 lbs. 1 foot per second for ten hours in a day.

The *maximum power* of a strong man, exerted for $2\frac{1}{2}$ minutes, is equivalent to 18,000 lbs. raised one foot in a minute.

A man of ordinary strength exerts a force of 30 lbs. for 10 hours in a day with a velocity of $2\frac{1}{2}$ feet in a second, which is about equal to 4500 lbs. raised 1 foot in a minute.

The average weight of men is 150 lbs. each.

A man travels, without a load, on level ground, for $8\frac{1}{2}$ hours a day, at the rate of $3\frac{7}{10}$ miles an hour, or $31\frac{1}{4}$ miles per day. He can carry 111 lbs. 11 miles in a day.

A porter going short distances, and returning unloaded, carries 135 lbs. 7 miles in a day. He can carry, in a wheelbarrow, 150 lbs. 10 miles a day.

An average strong man will, for a short period, exert a force with a—

		lbs.			lbs.
Drawing knife..........	equal to	100	Pincers, compression.....	equal to	60
An auger, both hands...	"	100	A hand-plane	"	50
A screw-driver, 1 hand..	"	84	A hand-saw.............	"	36
A bench-vice handle....	"	72	A thumb-vice............	"	45
A chisel, vertical pressure	"	72	A brace-bit, revolving.....	"	16
A windlass............	"	60			

HORSE POWER.

Before the invention and improvement of the steam-engine, the force of horses was very extensively used as a motive power; and although its application to machinery is now much less frequent, it is still resorted to, especially in places where fuel is expensive. For ordinary farm labor, it will probably never be superseded. The following are some of the more important facts relating to the horse and horse-power:—

The ordinary work of a horse is taken at 22,500 lbs. raised 1 foot in a minute, for 8 hours a day.

The strength of a horse is equivalent to that of 5 men.

A *draught-horse* can draw 1600 lbs. 23 miles a day on a level road, weight of carriage included.

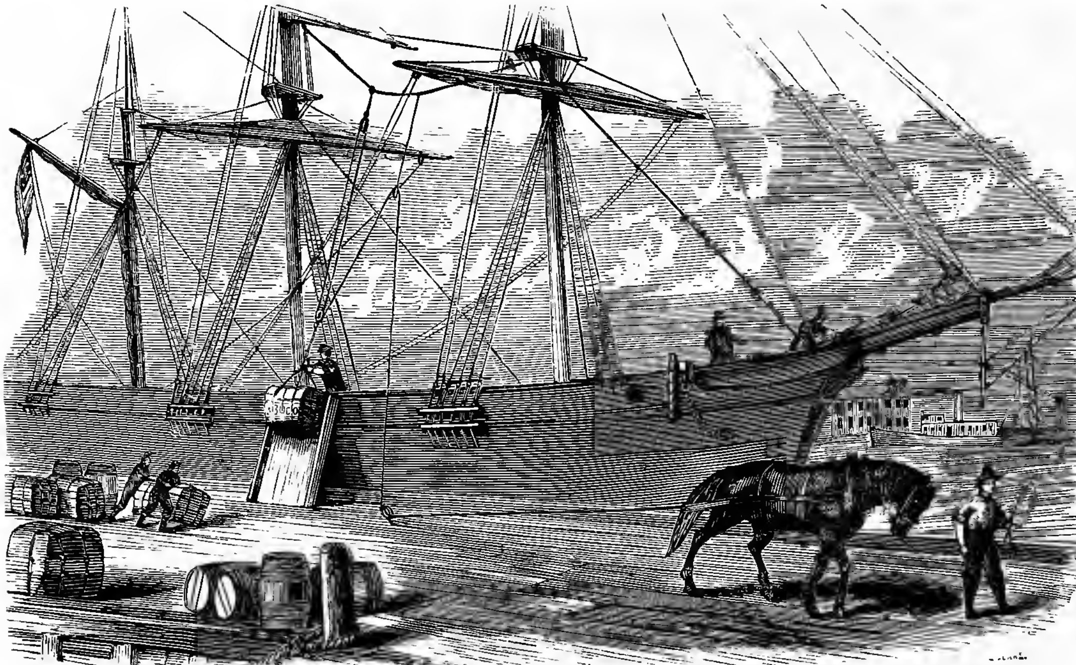
In a *horse-mill*, he moves at the rate of 3 feet per second on a track 25 feet diameter, and with the machine exerts the power of 4½ horses.

He occupies in a stall a front of 4½ feet and a depth of 10 feet.

The average weight of horses is 1000 lbs. each.

A horse travels 400 yards, *at a walk*, in 4½ minutes; 400 yards, *at a trot*, in 2 minutes; and 400 yards, *at a gallop*, in 1 minute.

A horse will *carry* 250 lbs. 25 miles a day of 8 hours.



HORSE POWER ILLUSTRATED.—LOADING A SHIP.

A horse will live 25 days without solid food, merely drinking water. He will live 17 days without either eating or drinking. He will live only 5 days when eating solid food, without drinking.

He attains his full growth in 5 years, and will live 25. His average life is 16 years.

Horse-power as applied to the measurement of steam-engines and waterfalls was first applied by James Watt, the inventor of the steam-engine. From a series of experiments he ascertained that the average strength of a horse was sufficient to raise 33,000 lbs. one foot per minute,* and this unit has been adopted in this country and in England as a general measure of power.

A waterfall is thus said to have a horse-power for every 33,000 lbs. of water passing a given point per minute for each foot of the fall. To compute the power of a waterfall is given the following

Rule.—Divide the continued product of the width, the depth, the velocity of the water per minute, the height of the fall, and the weight of a cubic foot of water ($62\frac{1}{2}$ lbs.) by 33,000.

Example.—The flume of a mill is 10 feet wide, the water is 3 feet deep, the velocity is 100 feet per minute, and the fall 11 feet. What is the horse-power of the fall?

Operation.—$(10 \times 3 \times 100 \times 11 \times 62\frac{1}{2}) \div 33{,}000 = 62\frac{1}{2}$ horse-power.

* This is done by means of compound pulleys.

The power of a steam-engine is estimated by the following

RULE.—Divide the continued product of the area of the piston in inches, the mean pressure per square inch in pounds, the length of the stroke in feet, and the number of strokes per minute by 33,000.

EXAMPLE.—The area of the piston of a steam-engine is 40 inches, the pressure is 60 lbs. per square inch, the length of the stroke is 3 feet, and it makes 30 strokes per minute. What is the horse-power?

OPERATION.—$(40 \times 60 \times 3 \times 30) \div 33,000 = 6\frac{1}{2}$ horse-power (nearly).

Water-wheels lose from 10 to 50 per cent. of the power, and the actual power of the steam-engine is less than that indicated by the horse-power, owing to a loss by friction, the amount of which depends upon the arrangement of the engine and the perfection of the workmanship.

TABLE, *showing the labor one horse is able to perform at different rates of speed on canals, railroads, and turnpikes. Drawing force,* $83\frac{1}{3}$ *lbs.*

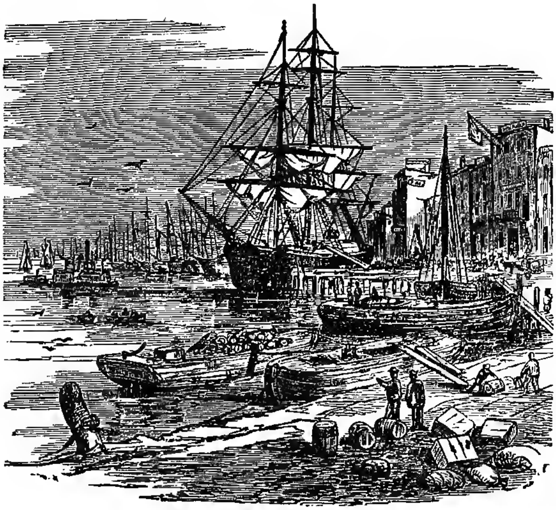
Speed per hour. Miles.	Duration of day's work—hours.	Useful effect for 1 day in tons, drawn 1 mile.		
		On canal—tons	On a railroad—tons.	On a turnpike—tons.
$2\frac{1}{2}$	$11\frac{1}{2}$	520	115	14
3	8	243	92	12
$3\frac{1}{2}$	6	154	82	10
4	$4\frac{1}{2}$	102	72	9
5	$2\frac{9}{10}$	52	57	7.3
6	2	30	48	6
7	$1\frac{1}{2}$	19	41	5
8	$1\frac{1}{8}$	12.8	36	4.5
9	$\frac{9}{10}$	9.	32	4.
10	$\frac{3}{4}$	6.5	28.8	3.6

TABLE, *showing how much one team and plough will perform in a day, in acres and tenths.*

Width of furrow in inches.	Acres and tenths.	Width of furrow in inches.	Acres and tenths.	Width of furrow in feet	Acres and tenths.	Width of furrow in feet.	Acres and tenths.
5	1.0	12	2.4	2	4.8	5½	13.2
6	1.2	14	2.8	2½	6.0	6	14.4
7	1.4	16	3.2	3	7.2	6½	15.6
8	1.6	18	3.6	3½	8.4	7	16.8
9	1.8	20	4.0	4	9.6	7½	18.0
10	2.0	22	4.4	4½	10.8	8	19.2
11	2.2			5	12.0		

NOTE.—The above table is constructed on the presumption that the team moves at the rate of about 3 feet per second, or 2 miles per hour, for 10 hours per day. Horses and mules in good condition will do this

FREIGHTS—QUANTITY OF GOODS WHICH COMPOSE A TON IN SHIPPING.



Wharf Scene in New York.

From By-laws of the New York Chamber of Commerce.

Resolved, That when vessels are freighted by the ton, and no special agreement is made between the owner of the vessel and freighter of the goods, respecting the proportion of tonnage which each particular article shall be computed at, the following regulation shall be the standard of computation:—

That the articles, the bulk of which shall compose a ton, to equal a ton of heavy materials, shall be in weight as follows: 1568 lbs. of coffee in casks, 1830 lbs. in bags; 1120 lbs. of cocoa in casks, 1307 lbs. in bags.

952 lbs. pimento in casks, 1110 in bags.

Eight barrels of flour, 196 lbs. each.

Six barrels of beef, pork, tallow, pickled fish, pitch, tar, and turpentine.

Twenty hundred pounds of pig and bar iron, potashes, sugar, logwood, fustic, Nicaragua wood, and all heavy dyewoods, rice, honey, copper ore, and all other heavy goods.

Sixteen hundred pounds of coffee, cocoa, and dried codfish, in bulk, and twelve hundred pounds of dried codfish in casks of any size.

Six hundred pounds of ship bread in casks, seven hundred in bags, and eight hundred in bulk.

Two hundred gallons (wine-measure), reckoning the full contents of the casks, oil, wine, brandy, or any kind of liquors.

Twenty-two bushels of grain, peas, or beans, in casks.

Thirty-six bushels of grain in bulk.

Thirty-six bushels of European salt.

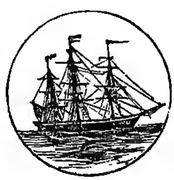
Thirty-one bushels of salt from the West Indies.

Twenty-nine bushels of sea-coal.

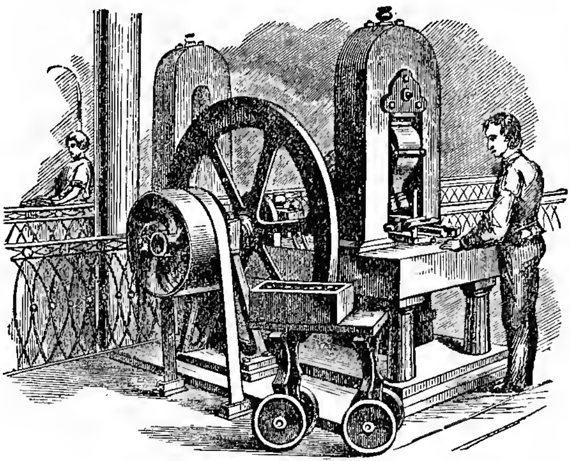
Forty feet (cubic measure) of mahogany, square timber, oak plank, pine, and other boards, beavers, furs, peltry, bees wax, cotton, wool, and bale goods of all kinds.

One hogshead of tobacco, and ten hundred pounds of dry hides.

Eight hundred pounds of China raw silk, ten hundred pounds of net bohea, and 800 green tea.



UNITED STATES OR FEDERAL MONEY.



Stamping Coin at the United States Mint.

Money is value, or the representative of value, used for the purposes of exchange. In different countries, at different times, various articles have been used for money, such as oxen, pieces of leather stamped, shells, wampum, iron, nails, &c. Gold and silver, at present, are used almost exclusively for money. They are called precious metals.

Paper money is a substitute for coin.

Uncoined gold and silver is called *bullion.*

Coin is a piece of metal of known weight used for money, the value of which is stamped on it.

Currency is the money of circulation.

Tokens are coins whose intrinsic value is below that assigned them by law. Such coins are said to be coins in *billion.*

United States or Federal money is a decimal currency.

TABLE.

10 mills (m.)	1 cent	ct.		
10 cents	1 dime	d.	100 mills.	
10 dimes	1 dollar	$	1000 "	100 cents.
10 dollars	1 eagle	E.	10000 "	1000 cents 100 dimes.

COINS.—The gold coins are the *double-eagle, eagle, half-eagle, quarter-eagle, three-dollar piece,* and *dollar.*

NOTES.—1. The fifty-dollar piece is not a legal coin. The copper half-cent is no longer coined. The mill is not a coin.

2. Gold coins contain 9 parts of gold and 1 part of an alloy of silver and copper.

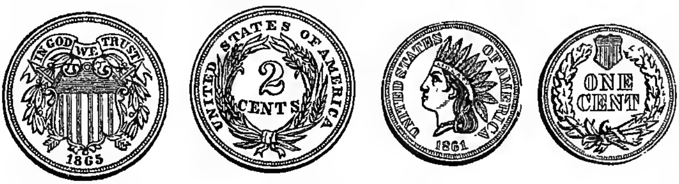
3. The silver coins are the *dollar*, *half-dollar*, *quarter-dollar*, *dime*, *half-dime*, and *three-cent piece.*

4. Silver coins contain 9 parts silver and 1 part copper, except the three-cent piece, which is 3 parts silver and 1 part copper.

5. The nickel coins are the *cent*, the new *three-cent*, and new *five-cent pieces.*

6. The nickel cent contains 88 parts copper and 12 parts nickel.

7. The copper coins are the *cent* and *two-cent pieces.*



8. The two-cent and cent pieces are made of nickel and copper.

The term *dollar* is supposed to be derived from the German "thaler," pronounced *ta-ler.*

The term *dime* means ten, *cent* a hundred, and *mill* a thousand.

The origin of the dollar-mark is uncertain; some think it the combination of U. S., others that it is an imitation of the dollars and scroll on the "pillar-dollar."

1 eagle (gold) weighs 258 troy grains.
1 dollar (silver) " 412.5 "
1 cent (copper) " 168 "
23.2 grains of pure gold=$1.00.

Gold coin of the United States, prior to 1834, like that of England,=88.8 cents per dwt. By act of Congress of 1834, its value was made 94.8 cents per dwt. The old United States Eagle, coined previous to 1834, is worth $10.66·8.

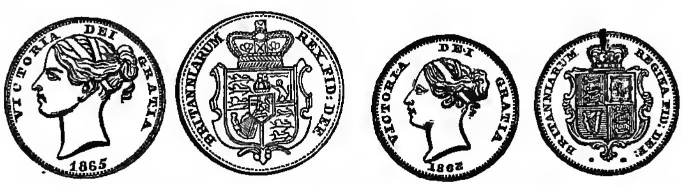
ENGLISH MONEY.

English or Sterling Money is the currency of Great Britain.

TABLE.

4 farthings (far. or qr.)	make	1 penny,	marked d.
12 pence	"	1 shilling,	" s.
20 shillings	"	1 pound or sovereign, £, sov.	
21 shillings	"	1 guinea, marked guin.	

COINS.—The gold coins are the *sovereign* (£1), and the *half-sovereign* (10s.).



The silver coins are the *crown* (5s.), the *half-crown* (2s. 6d.), the *florin* (2s.), the *shilling* (12d.), *sixpenny-piece* (6d.), and *threepenny-piece* (3d.).

The bronze coins are the *penny*, *half-penny*, and *farthing*. Farthings are generally written as fractions of a penny, thus: 1 far.$=\frac{1}{4}$d.; 2 far.$=\frac{2}{4}$ or $\frac{1}{2}$; 3 far.$=\frac{3}{4}$.

Canadian currency is decimal, and the denominations are the same as Federal money.

The franc is the unit of the French decimal currency, and is worth $0.186. The denominations are *francs* and *centimes*.

NOTES.—1. The symbol £ stands for the Latin word *libra*, a pound; *s.* for *solidus*, a shilling; *d*, for *denarius*, a penny; *qr.* for *quadrans*, a quarter.

2. The term *sterling* is supposed to be derived from *Easterling*, a name formerly given to the early German traders.

3. The term *farthing* is derived from "four things," denoting the divisions on the old English penny.

AVOIRDUPOIS WEIGHT.

Avoirdupois weight is used for all ordinary purposes.

TABLE.

16 drams (dr.)	1 ounce,	marked	oz.
16 oz.	1 pound,	"	lb.
25 lb.	1 quarter,	"	qr.
4 qr.	1 hundredweight,	"	cwt.
20 cwt.	1 ton,	"	T.
100 lb.	1 cental,	"	c.

T.	cwt.	qr.	lb.
1	= 20	= 80	= 2000
	1	= 4	= 100
		1	= 25

lb.	oz.	dr.	gr.*
1	= 16	= 256	= 7000
	1	= 16	= $437\frac{1}{2}$
		1	= $27\frac{11}{32}$

NOTES.—1. The gross ton of 2240 lbs. was formerly in common use, but is now seldom used except at the United States Custom House and at the Pennsylvania coal mines.

2. Butter is usually packed for market in pails or firkins, which hold from 50 to 100 pounds.

3. The term *avoirdupois* is derived from the French "avoir du poids," meaning *goods of weight*. *Cwt.* is formed from *c.*, *centum*, *wt.*, *weight*.

4. Most of the States have adopted the following

TABLE OF MISCELLANEOUS WEIGHTS.

196 lbs.	make	1	barrel of	flour.
200 "	"	1	"	beef, pork, or fish.
280 "	"	1	"	salt at N. Y. Salt Works.
32 "	"	1	bushel of	oats.
48 "	"	1	"	barley.
56 "	"	1	"	corn or rye.
60 "	"	1	"	wheat.
60 "	"	1	"	beans.
14 "	"	1	"	blue-grass-seed.
46 "	"	1	"	castor-beans.
60 "	"	1	"	clover-seed.
56 "	"	1	"	flax-seed.
44 "	"	1	"	hemp-seed.

* NOTE.—The exact weight of an avoirdupois dram is $27\frac{11}{32}$ troy grains.

60	lbs.	make	1	bushel of	peas.
60	"	"	1	"	potatoes.
45	"	"	1	"	timothy-seed.
57	"	"	1	"	onions.
28	"	"	1	"	apples or peaches (dried).
50	"	"	1	"	salt.

A sack of wool is 22 stone, that is, 14 lbs. to the stone, 308 lbs.

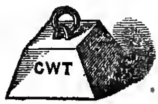
A pack of wool is 17 stone 2 lbs.=240 lbs.—a pack load for a horse.

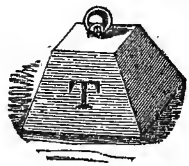
A truss of hay is, new, 60 lbs.; old, 50 lbs.; straw, 40 lbs. *A load of hay* is 36 trusses. *A bale of hay* is 300 lbs.

A firkin of butter was formerly 56 lbs.

A bale of cotton is 400 lbs., but it is put up in different States varying from 280 to 720 lbs. Sea Island cotton is put up in sacks of 300 lbs.

Avoirdupois Weight Illustrated.



1 firkin.

1 barrel.

1 barrel.

1 barrel.

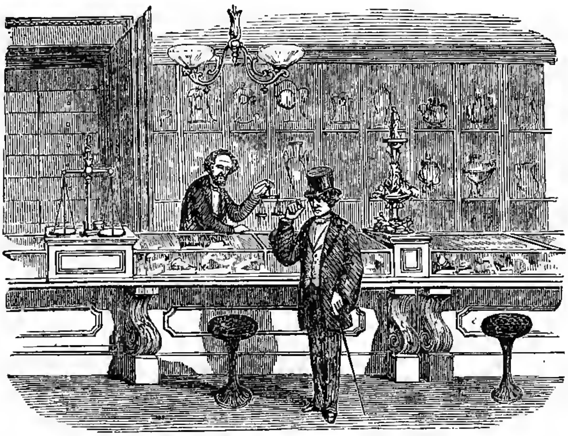
1 bushel.

1 bushel.

1 bushel.

1 bushel.

TROY WEIGHT.



Troy weight is used in weighing gold, silver, and jewels, and in philosophical experiments.

TABLE.

24 grains (gr.)	make	1 pennyweight,	marked	pwt.
20 pwt.	"	1 ounce,	"	oz.
12 oz.	"	1 pound,	"	lb.
$3\frac{1}{5}$ grains	"	1 carat (diamond wt.)	"	k.

SCALE OF COMPARISON.

lb.		oz.		dwt.		gr.
1	=	12	=	240	=	5760
		1	=	20	=	480
				1	=	24
				1k.	=	$3\frac{1}{5}$

24 grs. 480 grs. 5760 grs.

NOTES.—1. A carat is a weight of about 3.2 grains, and is used by jewellers to weigh diamonds. The term *carat* is also used to denote the fineness of gold. When gold contains 18 parts pure gold and 6 parts alloy, which is usually silver and copper, it is said to be 18 carats fine. Gold 14 carats fine contains 14 parts pure gold and 10 parts alloy, &c.

2. The term *Troy* is derived from *Troyes*, where the weight was first introduced into Europe, about the 12th century.

3. The term *pennyweight* is derived from the weight of the old silver penny. The term *grain* is derived from the custom of using the grains of wheat, 24 of which were taken to determine the weight of a pennyweight.

4. The symbol *oz.* is derived from the Spanish word *onza*, an ounce; *lb.* is from the Latin libra, a pound.

5. The standard unit of weight is the troy pound. It equals the weight of 22.79+cu. in. of distilled water at the temperature of 39° 83′ F., the barometer being at 30 in.

APOTHECARIES' WEIGHT.

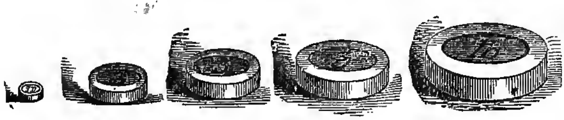
Apothecaries' weight is used in preparing prescriptions, but drugs and medicines are bought and sold by avoirdupois weight.

TABLE.

20 grains (gr.)	1 scruple,	marked	sc.	or ℈.
3 scruples	1 drachm,	"	dr.	or ʒ.
8 drachms	1 ounce,	"	oz.	or ℥.
12 ounces	1 pound,	"	lb.	or ℔.

SCALE OF COMPARISON.

℔	℥	ʒ	℈	gr.
1 =	12 =	96 =	288 =	5760
	1 =	8 =	24 =	480
		1 =	3 =	60
			1 =	20



APOTHECARIES' FLUID MEASURE.

Apothecaries' fluid measure is used for measuring liquids in preparing medical prescriptions.

TABLE.

60 minims (♏)	1 fluid drachm,	marked	f ʒ.
8 fluid drachms	1 fluid ounce,	"	f ℥.
16 fluid ounces	1 pint,	"	O.
8 pints	1 gallon (wine meas.)	"	Cong.

NOTE.—1. The pound, ounce, and grain are the same as in troy weight, the ounce being differently subdivided.

2. The symbols are supposed to be derived from the inscriptions upon the ancient monuments of Egypt.

3. One minim equals one drop.

LIQUID OR WINE MEASURE.

Liquid measure is, of course, used in measuring liquids.

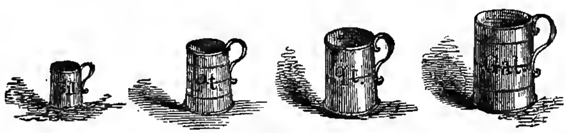
TABLE.

4	gills (gi.)	1 pint,	marked	pt.
2	pints	1 quart,	"	qt.
4	quarts	1 gallon,	"	gal.
31½	gallons	1 barrel,	"	bbl.
2	barrels or 63 gallons	1 hogshead,	"	hhd.

Scale of Comparison.

Wine Measure.				
gal.	qt.	pt.	gi.	cu. in.
1	=4	=8	=32	=231
	1	=2	= 8	$=57\frac{3}{4}$
		1	= 4	$=28\frac{7}{8}$

Dry Measure.					
bu.	pk.	qt.	pt.	cu. in.	
1	=4	=32	=64	$=2150\frac{3}{4}$	nearly.
	1	= 8	=16	$= 537\frac{1}{2}$	"
		1	= 2	$= 67\frac{1}{5}$	"



NOTE.—1. The denominations barrel and hogshead are used in estimating the capacity of cisterns, reservoirs, vats, &c.

2. The barrel, hogshead, tierce, pipe, butt and tun, are the names of casks, which are usually gauged, having the number of gallons they hold marked on them.

3. Ale or beer measure, formerly used in measuring beer, ale, and milk, is now seldom used.

4. 1 gallon of pure water weighs nearly $8\frac{1}{8}$ lb. avoirdupois, hence a pint weighs about a pound.

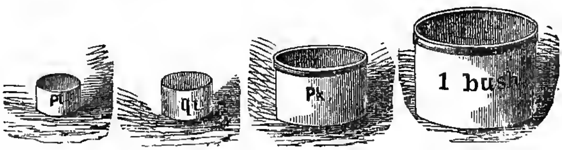
5. The standard unit of wine measure is the gallon, which contains 231 cubic inches.

The Imperial, or British gallon, contains 277.274 cubic inches.

DRY MEASURE.

Dry measure is used in measuring vegetables and articles not fluid.

2 pints (pt.)	1 quart,	qt.
8 quarts	1 peck,	pk.
4 pecks	1 bushel,	bu.
36 bushels	1 chaldron,	cald.



NOTES.—The standard bushel is the Winchester, which contains 2150.42 cubic inches, or 77.627 lbs. avoirdupois of distilled water at its maximum density.

Its dimensions are 18½ inches diameter inside- 19½ inches outside, and 8 inches deep, and when heaped to a cone 6 inches high, contains 2748 cubic inches.

The Imperial or British bushel contains 2218 cubic inches, so that 32 of their bushels are equal to 38 of ours.

Heaping Measure.—Potatoes, turnips and esculent roots, apples and other fruits, meal and bran, corn on the ear, and in some States, oats, are sold by the heaping bushel measure.

TABLE OF COMPARISON OF THE MEASURES OF CAPACITY.

1 gallon or 4 qt.	wine measure	contains	231	cubic inches.
$\frac{1}{2}$ pk. or 4 qt.	dry measure	"	$268\frac{4}{5}$	"
1 gallon or 4 qt.	beer measure	"	282	"
1 bushel	dry measure	"	$2150\frac{1}{5}$	"

In England the following weights and measures are sometimes used:

WEIGHT.

3 pounds=1 stone, butchers' meat.
7 pounds=1 clove.
2 cloves=1 stone common articles.
2 stone=1 tod of wool.
$6\frac{1}{2}$ tods=1 wey "
2 weys=1 sack "
12 sacks=1 last "
240 pounds=1 pack "

CLOTH MEASURE.

$2\frac{1}{4}$ inches=1 nail.
4 nails=1 quarter.
4 quarters=1 yard.
3 quarters=1 Flemish ell.
5 quarters=1 English ell.
6 quarters=1 French ell.
$4\frac{2}{15}$ quarters=1 Scotch ell.

DRY MEASURE.

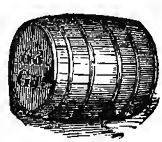
2 quarts=1 pottle.
2 bushels=1 strike.
2 strikes=1 coom.
2 cooms=1 quarter.
5 quarters=1 load.
3 bushels=1 sack.
36 bushels=1 chaldron.

WINE MEASURE.

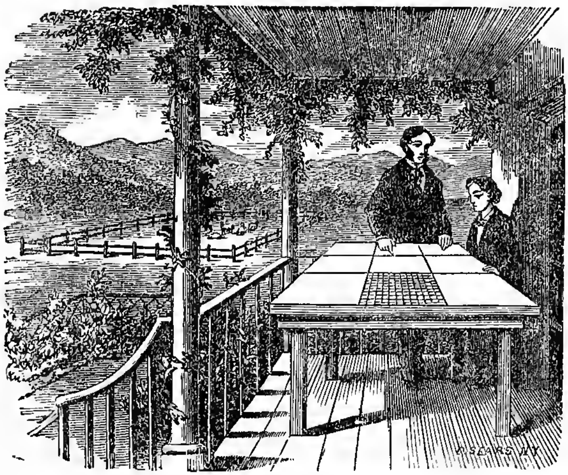
18 U. S. gal =1 runlet.
25 Eng. gal. or 42 U. S. gal. =1 tierce.
2 tierces=1 puncheon.
$52\frac{1}{4}$ Eng. gal. or 63 U. S. gal. =1 hogshead.
2 hogsheads=1 pipe.
2 pipes=1 tun.
$7\frac{1}{2}$ Eng. gal.=1 firkin of beer.
4 firkins=1 barrel "

TABLE OF THE COMPARISON OF WEIGHTS, &c.

1 U. S. pound Troy	=5760 grs. Troy.	1 English yard	=36 inches.
1 Eng. pound Troy	=5760 " "	1 French metre	=39.368+inches.
1 pound Apoth.	=5760 " "	1 U. S. bushel	=2150.42+cu. in.
1 U. S. pound Av.	=7000 " "	1 Eng. "	=2218.19+ "
1 Eng. pound Av.	=7000 " "	1 U. S. gallon	=231. "
144 pounds Av.	=175 lb. "	1 Eng. "	=277.26+ "
1 French gramme	=15.433 grs. Troy.	1 French litre	=61.533+ "
1 U. S. yard	=36 inches.	1 French are	=119.664 sq. yds.



SQUARE MEASURE.



Square measure is used in calculating areas or surfaces, as of land, lumber, painting, paving, &c.

Table.

144	square inches (sq. in.)	make	1 square foot,	marked	sq. ft.
9	square feet	"	1 square yard,	"	sq. yd.
$30\frac{1}{4}$	square yards	"	1 square rod,	"	sq. rd., P.
40	square rods	"	1 rood, or qr. acre,	"	R.
4	roods	"	1 acre,	"	A.
640	acres	"	1 sq. mile or section,	"	sq. m., sec.

Scale of Comparison.

A.	R.	P.	sq. yds.	sq. ft.	sq. in.
1=	4=	160=	4840 =	43560 =	6272640.
	1=	40=	1210 =	10890 =	1568160.
		1=	$30\frac{1}{4}$=	$272\frac{1}{4}$=	39204.
			1 =	9 =	1296.
				1 =	144.

Note.—Artificers usually estimate their work—1. In glazing and stone-cutting, by the square foot. 2. In painting, plastering, paper-hanging, &c., by the square yard. 3. In flooring, roofing, slating, &c., by the 100 square feet. 4. In bricklaying, by the thousand bricks, by the square yard, and 100 feet.

The painting of mouldings, cornices, &c., is estimated by measuring the entire surface.

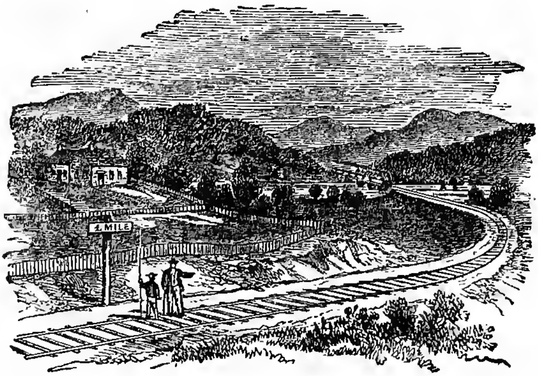
When bricklaying is estimated by square measure, the work is understood to be 12 inches thick.

Surveyor's square measure is used in finding the area of land.

Table.

625 square links (sq. l.)	make 1 sq. rod,	marked	sq. rd.
16 sq. rods	" 1 sq. chain,	"	sq. ch.
10 sq. chains	" 1 acre,	"	A.
640 acres	" 1 sq. mile,	"	sq. mi.
36 sq. miles (six miles square)	" 1 township,	"	Tp.

LONG MEASURE.



Long measure is used for distances, &c.

TABLE.

12 lines or 3 barley-corns	1 inch,	
12 inches	1 foot,	marked ft.
3 ft.	1 yard,	" yd.
$5\frac{1}{2}$ yd.	1 rod,	" rd.
40 rd.	1 furlong,	" fur.
8 fur.	1 mile,	" mi.

SCALE OF COMPARISON.

mi.	fur.	rod.	yd.	ft.	in.
1=	8=	320=	1760 =	5280 =	63360
	1=	40=	220 =	660 =	7920
		1=	$5\frac{1}{2}$=	$16\frac{1}{2}$=	198
			1 =	3 =	36
				1 =	12

SURVEYORS' MEASURE.

Gunter's chain is used by land surveyors. It is 4 rods or 66 feet long, and contains 100 links.

Table.

25 links (li.)	1 rod,	rd.
4 rods	1 chain,	ch.
80 chains	1 mile,	mi.

Table of Miscellaneous Linear Measure.

3 inches	1 palm.	
4 inches	1 hand.	Used in measuring the height of horses at the shoulder.
9 inches	1 span.	
3 feet	1 pace or step.	
3.28 feet	1 metre.	
6 feet	1 fathom.	Used in measuring depths at sea.
880 fathoms	1 mile.	Used in measuring depths at sea.
3 geographical miles	1 league.	
60 " "	1 degree.	Of latitude
$69\frac{1}{4}$ statute "	1 degree.	Of longitude on the equator.

Note.—A hair's breadth is the 48th part of an inch.

A ship's cable is a chain, usually about 120 fathoms or 720 feet long, hence the term "cable length" in nautical language denotes about that distance.

Notes.—1. A knot is a nautical or geographical mile. Thus, the phrase, "thirteen knots an hour," means thirteen geographical miles an hour.

2. 1 English mile equals 5280 feet, and 1 nautical, or geographical mile, equals 6086 feet.

3. The geographic mile equals about 1.15 English miles; the German short mile, about 3.9 English miles; the German long mile, about 5.75 English miles; the Prussian mile about 4.7 English miles; the Spanish common league, about 4.2 miles; and the Spanish judicial league about 2.6 miles.

4. Measures of length were at first derived from the different parts of the body, as the *finger*, *hand*, the *span*, or the length of the thumb and middle finger extended; *cubit*, or the length of the forearm; and the *fathom*, or the length of the two arms extended.

CLOTH MEASURE.

Cloth measure is used by merchants in the sale of cloth, ribbons, laces, &c.

TABLE.

2 sixteenths (16th)	1 eighth,	marked 8th, $\frac{1}{8}$ yd.
2 eighths	1 quarter,	" qr., $\frac{1}{4}$ yd.
2 quarters	1 half,	" hlf., $\frac{1}{2}$ yd.
4 quarters or 2 halves	1 yard,	" yd.

NOTE.—The old system of measuring cloth is not now used. By it each yard is divided into 4 quarters, and each quarter into 4 nails, a nail being $2\frac{1}{4}$ inches. 3 quarters make a Flemish ell, 5 quarters an English ell, and 6 quarters a French ell.

CUBIC MEASURE.

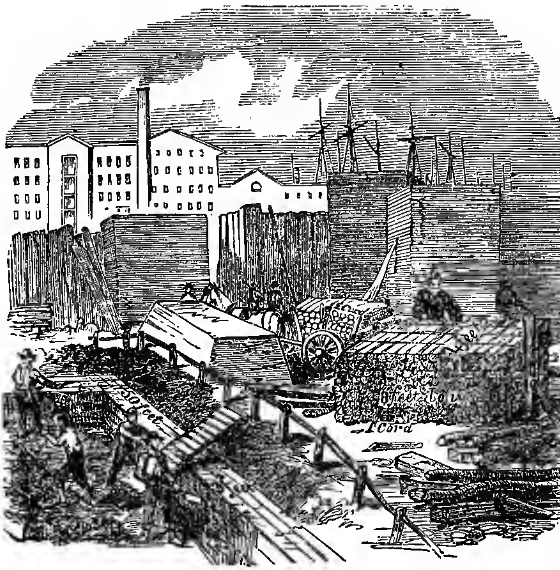
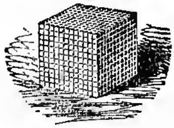


TABLE.

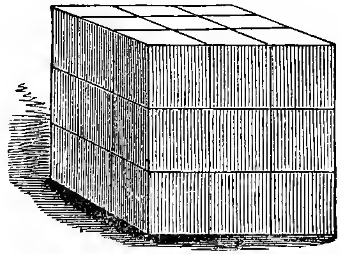
1728 cubic inches (cu. in.)	1 cubic foot,	marked	cu. ft.
27 cubic feet	1 cubic yard,	"	cu. yd.
40 cubic ft. of round timber or 50 cubic feet of hewn timber	1 ton or load,	"	T.
16 cubic feet	1 cord foot,	"	cd. ft.
8 cord feet or 128 cubic feet	1 cord of wood,	"	Cd.
$24\frac{3}{4}$ cubic feet	1 perch or stone, or masonry.	"	Pch.

Cubic measure is used in estimating the contents of solids; as wood, stone, capacity of cisterns, &c.

Cubic inch.



Cubic foot.



Cubic yard.

To find the cubic contents of any solid body.

RULE.—Multiply the length by the breadth, and that product by the thickness.

NOTES.—1. A load of earth contains a cubic yard, and weighs about 3250 lbs.

2. Railway and transportation companies estimate light freight by the number of cubic feet it occupies; but heavy freight is estimated by weight.

3. A pile of wood 4 feet wide, 4 feet high, and 8 feet long, contains 1 *cord;* and a *cord foot* is 1 foot in length of such a pile.

4. A perch of stone or masonry is $16\frac{1}{2}$ feet long, $1\frac{1}{2}$ feet wide, and 1 foot high, and contains $24\frac{3}{4}$ cubic feet.

5. A brick is usually 8 inches long, 4 inches wide, and 2 inches thick; hence 27 bricks make a cubic foot.

6. Joiners, painters, and masons make no allowance for windows, doors, &c. Masons make no allowance for the corners of the walls of houses or of cellars. The size of a

cellar is estimated by the measurement of the outside of the wall.

Ton weight and ton measure.—A ton of hay, or any other coarse bulky article usually sold by that measure, is 20 gross hundreds, that is 2240 lbs. But in many places it has become the custom to count only 2000 lbs. for a ton. In freighting ships, 42 cubic feet are allowed to a ton; in the measurement of timber, 40 solid feet if round, and 50 if square make a ton.

THE METRIC SYSTEM OF WEIGHTS AND MEASURES.*

The metric system of weights and measures had its origin in France during the Revolution in the year 1790. The following year a commission of scientific men was appointed by the government to select an appropriate unit, and as the result of their investigations the *ten-millionth* part of the earth's quadrant was chosen and called a *Metre*. To determine the unit of *weight* a cube of pure water at its greatest density, each edge of which is *one-hundredth* of a metre, was taken and called a *Gramme* (anglicized *gram*). The multiples and subdivisions were made to correspond to the decimal scale, hence its great simplicity.

This system was declared obligatory in France after Nov. 2, 1801; but no penalty was attached to non-conformity until after Jan. 1, 1841. The system has since been adopted wholly or in part by Spain, Belgium, Portugal, Holland, Great Britain, Greece, Italy, Norway, Sweden, Mexico, Guatemala, Venezuela, Ecuador, U. S. of Columbia, Brazil, Chili, San Salvador, and the Argentine Republic. In 1866

* The following article on the Metric System of Weights and Measures was prepared for this work by S. A. Felter, A.M., author of a well-known series of mathematical text-books.

Congress authorized the metric system in the United States by passing the following bill:—

AN ACT TO AUTHORIZE THE USE OF THE METRIC SYSTEM OF WEIGHTS AND MEASURES.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the passage of this act, it shall be lawful throughout the United States of America to employ the weights and measures of the metric system; and no contract or dealing, or pleading in any court, shall be deemed invalid or liable to objection, because the weights or measures expressed or referred to therein are weights or measures of the metric system.

SEC. 2.—*And be it further enacted,* That the tables in the schedule hereto annexed, shall be recognized in the construction of contracts, and in all legal proceedings, as establishing, in terms of the weights and measures now in use in the United States, the equivalents of the weights and measures expressed therein in terms of the metric system; and said tables may be lawfully used for computing, determining, and expressing, in customary weights and measures, the weights and measures of the metric system.

The utility of the metric system commends itself, even at a glance, and hence it becomes important that all should become acquainted with it. It will doubtless soon come into general use to the exclusion of all other systems of weight and measure. The following is a brief and condensed view of the system, so clear and simple that a child can understand it:—

The Metric System of weights and measures is formed upon the decimal scale, and has for its base an invariable unit derived from nature, and called a METRE; and upon this unit all the units of weight and measure are based.

The Metre is the *ten-millionth* part of the distance from the equator to the pole; and is the principal unit of linear measure.

The Are is a square whose side is ten *metres.* It is the principal unit of superficial measure.

The Stere is a cube whose edge is a *metre.* It is the principal unit of solid or cubic measure.

The Litre is a cube whose edge is the *tenth* of a *metre.* It is the principal unit of all *measures of capacity.*

The Gram is the weight of a cube of pure water at its greatest density, whose edge is the *hundredth* part of a *metre.* A litre of water weighs 1,000 grams. It is the principal unit of weight.

The names of the derivative denominations are formed by joining a Latin or Greek prefix to the principal units. There are seven of these prefixes, derived as follows:

Latin.	MILLI,	from *Millesimus,*	*a thousandth.*
	CENTI,	from *Centesimus,*	*a hundredth.*
	DECI,	from *Decimus,*	*a tenth.*

Greek.	DECA,	*ten.*		
	HECTO,	from *Hecaton,*	*one hundred.*
	KILO,	from *Chilioi,*	*one thousand.*
	MYRIA,	from *Myrioi,*	*ten thousand.*

The formation of the tables can be seen at a glance by the following:—

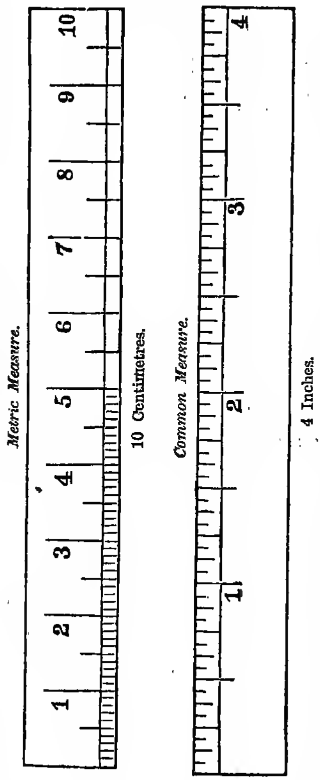
Milli					
Centi					
Deci					
Deca	METRE.	ARE.*	STERE.	LITRE.	GRAM.
Hecto					
Kilo					
Myria					

NAMES.	PRONUNCIATION.	ABB.	NAMES.	PRONUNCIATION.	ABB.
Millimetre	Mill'-e-mee'-ter	*mm.*	Hectostere	Hec'-to-steer	*hs.*
Centimetre	Sent'-e-mee'-ter	*cm.*	Kilostere	Kill'-o-steer	*ks.*
Decimetre	Des'-e-mee'-ter	*dm.*	Myriastere	Mir'-e-a-steer	*mys.*
Metre	Mee'-ter	*m.*	Millilitre	Mill'-e-li'-ter	*ml.*
Decametre	Dek'-a-mee'-ter	*dkm*	Centilitre	Sent'-e-li'-ter	*cl.*
Hectometre	Hec'-to-mee'-ter	*hm.*	Decilitre	Des'-e-li'-ter	*dl.*
Kilometre	Kill'-o-mee'-ter	*km.*	*Litre*	Li'-ter	*l.*
Myriametre	Mir'-e-a-mee'-ter	*mym.*	Decalitre	Dek'-a-li'-ter	*dkl.*
Milliare	Mill'-e-âre	*ma.*	Hectolitre	Hec'-to-li'-ter	*hl.*
Centiare	Sent'-e-âre	*ca.*	Kilolitre	Kill'-o-li'-ter	*kl.*
Deciare	Des'-e-âre	*da.*	Myrialitre	Mir'-e-a-li'-ter	*myl.*
Are	Are	*a.*	Milligram	Mill'-e-gram	*mg.*
Decare	Dek'-âre	*dka.*	Centigram	Sent'-e-gram	*cg.*
Hectare	Hec'-târe	*ha.*	Decigram	Des'-e-gram	*dg.*
Kilare	Kill'-âre	*ka.*	*Gram*	Gram	*g.*
Myriare	Mir'-e-âre	*mya.*	Decagram	Dek'-a-gram	*dkg.*
Millistere	Mill'-e-steer	*ms.*	Hectogram	Hec'-to-gram	*hg.*
Centistere	Sent'-e-steer	*cs.*	Kilogram	Kill'-o-gram	*kg.*
Decistere	Des'-e-steer	*ds.*	Myriagram	Mir'-e-a-gram	*myg.*
Stere	Steer	*s.*	Quintal	Quin'-tal	*q.*
Decastere	Dek'-a-steer	*dks.*	Tonneau	Tun'-no	*T.*

* The *a* in *deca* and *myria*, and the *o* in *hecto* and *kilo* are dropped when prefixed to *Are*.

LINEAR MEASURE.

Illustration.



NOTE.—By the accompanying illustration it will be seen that *one-tenth* of a metre, or ten centimetres, equals about $3\frac{15}{16}$ in., or a trifle short of 4 in.

This measure, as well as the other measures and weights, is written as whole numbers and decimals. The decimal point is placed at the right of the *unit;* thus, 4.167 *m.* may be written 416.7 *cm.* To make a metric rule, cut a piece of wood, paper, or tape, $39\frac{3}{8}$ in. long. Divide it into ten equal parts, and each part into ten *other* equal parts; each of these parts is 1 *centimetre.* Divide each centimetre into ten equal parts, and each part is a *millimetre.*

The diameter of the nickel five cent piece of 1866 is 2 *centimetres*, and its weight is 5 *grams.*

The Centimetre is the unit generally used for measurements less than a metre. For its length in common measure see illustration.

The Metre is the unit commonly used by artisans. It equals 3 ft. $3\frac{3}{8}$ in. (nearly).

The Kilometre is the unit commonly used by surveyors in measuring distances. Its length is 198 rd. 13 ft. 10 in.

TABLE.*

Full.

10 millimetres	=	1 centimetre.
10 centimetres	=	1 decimetre.
10 decimetres	=	1 *Metre.*
10 metres	=	1 decametre.
10 decametres	=	1 hectometre.
10 hectometres	=	1 kilometre.
10 kilometres	=	1 myriametre.

Contracted.

10 millimetres	=	1 centimetre.
100 centimetres	=	1 *metre.*
100 *metres*	=	1 kilometre.

SQUARE MEASURE.

The square Metre is the unit commonly used by artisans in specifying surfaces of small extent. It contains about 10 sq. ft. 110 sq. in.

The Are is the unit commonly used to express quantities less than the *hectare.* 100 ares make one hectare.

The Hectare is the unit commonly used by surveyors

* NOTE.—The unit of each table is divided into ten equal parts, designated by prefixing *deci* (tenth); as, *deci*gram. The *tenths* are divided into ten other equal parts, designated by prefixing *centi* (hundredth); as, *centi*gram. The *hundredths* are subdivided in the same manner, and are designated by prefixing *milli* (thousandth); as, *milli*gram. The contracted table is the most convenient for common use.

in estimating the contents of land. It contains 2.471 acres.

TABLE.

Full.			Contracted.		
10 milliares	=	1 centiare.	100 sq. millimetres	=	1 sq. centimetre.
10 centiares	=	1 deciare.	100 sq. centimetres	=	1 sq. decimetre.
10 deciares	=	1 *Are.*	100 sq. decimetres	=	1 sq. *metre.*
10 ares	=	1 decare.	100 sq. metres	=	1 *are.*
10 decares	=	1 hectare.	100 ares	=	1 *hectare.*
10 hectares	=	1 kilare.			
10 kilares	=	1 myriare.			

CUBIC OR SOLID MEASURE.

The cubic Metre or Stere is the unit commonly used by engineers in estimating the solid contents of embankments, cellars, walls, &c. It equals 1.308 cu. yards.

TABLE.

Full.			Contracted.		
10 millisteres	=	1 centistere.	1000 cu. centimetres	=	1 litre.
10 centisteres	=	1 decistere.	1000 litres	=	1 stere.
10 decisteres	=	1 *Stere.*	1000 steres	=	1 kilostere.
10 steres	=	1 decastere.			
10 decasteres	=	1 hectostere.			
10 hectosteres	=	1 kilostere.			
10 kilosteres	=	1 myriastere.			

DRY AND LIQUID MEASURE.

The unit commonly used in the measurement of grain, roots, and liquids by the barrel is the *hectolitre.* It equals 26.417 gal. wine measure, or 2.839 bu. dry measure.

The unit commonly used by grocers is the *litre.* It equals

1.056 qt. wine measure, or .908 qt. dry measure, or a trifle more than a wine quart.

TABLE.

Full.			*Contracted.*		
10 millilitres	=	1 centilitre.	100 centilitres	=	1 litre.
10 centilitres	=	1 decilitre.	100 litres	=	1 hectolitre.
10 decilitres	=	1 *Litre.*	1000 litres	=	1 kilolitre.
10 litres	=	1 decalitre.			
10 decalitres	=	1 hectolitre.			
10 hectolitres	=	1 kilolitre.			
10 kilolitres	=	1 myrialitre.			

WEIGHT.

The unit commonly used in philosophical experiments, by jewellers and druggists is the *gram.* Its weight is 15.432 gr. troy.

The unit commonly used by grocers is the *kilogram*, commonly contracted *kilo.* It is the weight of a litre of pure water, and equals 2.2046 lbs., or about $2\frac{1}{5}$ lbs. avoirdupois.

The unit commonly used in weighing heavy bodies, as coal, iron, marble, R. R. freight, &c., is the *tonneau.* It is the weight of a cubic metre of pure water, and equals 2204.6 lbs. avoirdupois.

TABLE.

Full.			*Contracted.*		
10 milligrams	=	1 centigram.	100 centigrams	=	1 gram.
10 centigrams	=	1 decigram.	1000 grams	=	1 kilogram.
10 decigrams	=	1 *Gram.*	1000 kilograms	=	1 tonneau.
10 grams	=	1 decagram.			
10 decagrams	=	1 hectogram.			
10 hectograms	=	1 kilogram.			
10 kilograms	=	1 myriagram.			
10 myriagrams	=	1 quintal.			
10 quintals	=	1 tonneau.			

MEASUREMENT OF ANGLES.

In the *centesimal* or French method the right angle is divided into 100 equal parts called *grades*, the grade into 100 equal parts called *minutes*, the minute into 100 equal parts called *seconds*.

TABLE.

100 seconds (")	=	1 minute (')
100 minutes	=	1 grade (gr.)
100 grades	=	1 right angle (r. a.)

NOTE.—Since the signs for both the common and centesimal methods are the same, to prevent confusion when minutes and seconds are expressed in the centesimal method, annex the abbreviation *cen.*; thus, 3′ 46″ *cen.*

CURRENCY.

SCALE.

Franc	decimes	centimes	millimes
0.	0	0	0

TABLE.

10 millimes	=	1 centime.
10 centimes	=	1 decime.
10 decimes	=	1 *Franc.*

LINEAR MEASURE.

Table of equivalents.*

1 in. = $25\frac{1}{3}$ mm. (nearly).
1 ft. = 305 mm. (nearly).
1 yd. = 914 mm.
1 rd. = 5029 mm.

1 mi. = 1609.35 *m.*
1 cm. = .3937 = $\frac{2}{5}$ in. (nearly).
1 m. = 39.37 in. = 1.093 yd.
1 km. = .62137 mi. = 198 rd., 12 ft., 10 in.

* Authorized by Act of Congress, July 27, 1866.

Square Measure.—*Table.*

1 sq. in.	=	6.5 sq. cm.
1 sq. ft.	=	9.3 sq. dm.
1 sq. yd.	=	.835 sq. m.
1 acre	=	40.47 a.

1 sq. cm.	=	.155 sq. in.
1 sq. m.	=	1550 sq. in. 10.76 sq. ft.
1 are.	=	119.6 sq. yd.
1 ha.	=	2.471 acres.

Cubic Measure.—*Table.*

1 cu. in.	=	16.387 cu. centm.
1 cu. ft.	=	28.34 litres. .0283 steres.
1 cu. yd.	=	.76531 steres.
1 cord	=	3.6281 steres.
1 fluid oz.	=	.02958 litres.
1 gal.	=	3.786 litres.
1 bus.	=	35.24 litres.

1 litre	=	1.0567 qt. liq. meas. .908 qt. dry meas.
1 hecto-litre	=	2.837 bu. dry meas. 26.417 gal. liq. meas.
1 kilolitre 1 cu. metre 1 stere	=	35.316 cu. ft. 1.308 cu. yd. 264.17 gal. liq. meas. .2759 cord.

Weight.—*Table.*

1 oz. troy	=	31.1 grams.
1 lb. troy 1 lb. apoth.	=	373.2 "
1 oz. avoir.	=	28.35 "
1 lb. avoir.	=	453.6 "

1 ton avoir.	=	907.2 kilos.
1 gram.	=	15.432 gr. troy. .5643 dr. avoir.
1 kilogram	=	2.2046 lb. avoir.
1 tonneau	=	2204.6 lb. avoir.

Angular Measure.—*Table.*

1 r. a.	=	100 grades.
1°	=	$1\frac{1}{9}$ grades.
1′	=	1.85 minutes ('cen.).
1″	=	3.08 seconds ("cen.).

1 cir.	=	400 grades.
1 grade	=	9 deg.
1′ cen.	=	5.4′.
1″ cen.	=	3.24″.

SPECIFIC GRAVITY.

When a cubic foot of a substance is compared with the same bulk of water, and weighs a certain number of times as much, that number is called its *specific gravity.*

When any substance weighs less than water, it will float on it, and when it weighs less than air, it will rise in it; thus, iron will float in melted lead, gas will rise in the air, and wood will float on water.

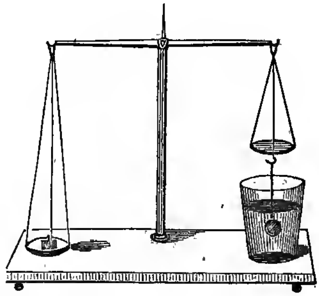
The weight of a cubic foot of water being 1000 ounces avoirdupois, it has been adopted as the standard of specific gravities. Hence the specific gravity of a body or substance is the proportion its weight bears to this standard.

To find the specific gravity of a body.

Rule.—Weigh it first in air and then in water, and take the difference of these weights; then as the difference is to the weight in air, so is 1000 to the specific gravity of the body.

Example.—What is the specific gravity of a stone weighing 20 lbs., but in water only 15 lbs.?

Solution.—20—15=5 difference; then 5 : 20 :: 1000 : 4000. *Ans.*



When the body is lighter than water.

Rule.—Attach to it a piece of metal sufficient to sink it in the water; weigh the piece added and the body separately, both in and out of the water, and find how much each loses in water by subtracting its weight in water from its weight in air, and subtract the less of these differences from the greater; then as the remainder is to the weight of the light body in air, so is 1000 to the specific gravity of the body.

Example.—Required the specific gravity of a piece of wood which weighs 20 lbs. in air; attached to it is a piece of metal, which weighs 30 lbs. in air and 25 lbs. in water, and the two pieces together weighing in water 10 lbs.?

Solution.—$20+30-10=40$
$30-25=\quad 5$

35 : 20 :: 1000 : 571.44. *Ans.*

To reduce the specific gravity of a body to its weight in lbs. per cubic foot.

Rule.—Divide the specific gravity by 16, and the quotient is the weight of a cubic foot in lbs.

Example.—Required the weight of a cubic foot of a substance the specific gravity of which is 4.800?

Solution.—$4.800 \div 16 = 300$ lbs. *Ans.*

TABLE, *showing the specific gravities of various substances.*

DESIGNATION.	Sp. Gravity.	DESIGNATION.	Sp. Gravity.	DESIGNATION.	Sp. Gravity
Antimony, ...	6.712	Coral, ...	2.700	Cork, ...	.240
Arsenic, ...	5.763	Coal, bit, ...	1.270	Cypress, ...	.644
Bismuth, ...	9.823	" anthr., ..	1.556	Ebony, ...	1.331
Brass.	7.820	Diamond, ...	3.521	Elder, ...	.695
Bronze	8.700	Earth, loose, ..	1.500	Elm, ...	.671
Copper, ...	8.788	Emery, ...	4.000	Fir, yellow, ..	.657
Copper wire, ..	8.878	Flint, ...	2.590	" white, ...	.669
Gold, pure, ...	19.258	Glass.	2.930	Lignum vitæ, ..	1.333
" 22 carat.	17.486	Granite, ...	2.625	Live oak, ...	1.120
" 20 carat	15.709	Grindstone, ...	2.143	Logwood, ...	.919
Iron, cast, ...	7.207	Gypsum, ...	2.168	Mahogany, ...	1.063
" bars, ...	7.778	Hone, white ..	2.876	Maple, ...	.750
Lead, ...	11.352	Ivory, ...	1.822	Mulberry, ...	.897
Mercury, ...	13.598	Limestone, ...	3.180	Orange, ...	.705
Platinum, ...	22.069	Lime, quick, ..	.804	Pine, yellow, ..	.660
Silver, ...	10.477	Manganese	7.000	" white, ..	.554
Steel, ...	7.833	Marble, par., ..	2.838	Pear, ...	.661
Tin, ...	7.291			Plum.	.785
Zinc, ...	6.861	DRY WOOD.		Quince, ...	.705
Alabaster, ...	2.730	Apple, ...	.793	Sassafras, ...	.482
Amber, ...	1.078	Adder, ...	.800	Walnut, ...	.671
Asbestos, ...	3.073	Ash, ...	.845	Willow, ...	.585
Borax, ...	1.714	Beech, ...	.852	Yew, ...	.798
Brick, ...	1.900	Box, ...	1.231	Hickory, ...	.838
Chalk, ...	2.784	Campeachy, ..	.913	Poplar, ...	.383
Charcoal, ...	.441	Cherry, ...	.715	" white, ..	.529
Clay, ...	1.930	Cocoa, ...	1.040		

When the specific gravity of a substance is given, to find the weight of a cubic foot.

RULE.—Multiply the weight of a cubic foot of pure water ($62\frac{1}{2}$ lbs.) by the specific gravity of the given substance.

I wish to find the number of cubic inches in a piece of cast iron, that will displace 25 ounces of water. What will it weigh?

OPERATION.—1. 25 oz. $\times 1728 = 43200$.

2. $43200 \div 1000 = 43$ cu. in. (nearly). *Ans.*

3. 25 oz. $\times 450\frac{1}{2} \div 1000 = 11$ lb. (nearly). *Ans.*

NOTE.—To find the number of cubic inches in any irregular body, weigh a vessel containing sufficient rain water to cover the solid, then immerse the solid in the water by means of a string or wire held in the hand, being careful not to touch the vessel. While the solid is immersed, weigh the water and vessel again; the difference will be the weight of the water displaced by the solid.

RULE.—I. Multiply the weight of the water in ounces by 1728, and divide by 1000, the result will be the contents in cubic inches.

II. To find the weight, multiply the weight of the water displaced in ounces by the weight of a cubic foot of the substance, and divide the product by 1000, and the result will be the weight in pounds.

I have a pattern of a lock that will displace 20 ounces of water; how much will 1000 copies of cast iron weigh? How much will they cost me at 9 cents per pound?

OPERATION.—$\overset{\text{oz.}}{20} \times 450\frac{1}{2} \div 1000 = 9.01$ lb.

$\overset{\text{lb.}}{9.01} \times 1000 \times 6.09 = \$810.90$. *Ans.*

I have a lead pattern of a wheel that displaces 15 ounces of water; what will 500 copies in brass cost me at 40 cents per pound?

OPERATION.—$\overset{\text{oz.}}{15} \times 504\frac{3}{4} \div 1000 = 7.571$ lb.

$\overset{\text{lb.}}{7.571} \times 500 \times \$.40 = \$1514.20$. *Ans.*

TABLE, *showing the weight of a cubic foot of different substances.*

				Avoir.
1 cubic foot of	Brass	weighs	504¾	lb.
" "	Brick	"	125	"
" "	Copper	"	555	"
" "	Clay	"	135	"
" "	Coal (anthracite)	"	54	"
" "	Coal (bituminous)	"	50	"
" "	Granite	"	165	"
" "	Iron (wrought)	"	486¾	"
" "	Iron (cast)	"	450½	"
" "	Lead	"	708¾	"
" "	Marble	"	171	"
" "	Soil (common)	"	124	"
" "	Sand	"	95	"
" "	Tallow	"	59	"
" "	Water (pure)	"	62½	"
" "	Water (sea)	"	64⅓	"
" "	Wood (oak)	"	55	"
" "	Wood (yellow pine)	"	42	"
" "	Wood (white pine)	"	30	"
" "	Charcoal (hard wood)	"	18½	"
" "	Charcoal (pine wood)	"	18	"
" "	Cork	"	15	"

VELOCITY.*

The average velocities of different objects are found in the following

* Parker's Philosophy.

TABLE.

	Per hour.		Per sec.
A man walks	3 miles,	or	4 feet.
A horse trots	7 "	or	10 "
A horse runs....................	20 "	or	29 "
Steamboat runs	18 "	or	26 "
Sailing vessel runs	10 "	or	14 "
Slow rivers flow	3 "	or	4 "
Rapid rivers flow................	7 "	or	10 "
A moderate wind blows	7 "	or	10 "
A storm moves...................	36 "	or	52 "
A hurricane moves	80 "	or	117 "
A rifle ball "	1000 "	or	1466 "
Sound "	743 "	or	1142 "
Light "	192000 miles per sec.		
Electricity "	288000 " " "		

SOLID MATTER AND WATER IN ARTICLES OF DIET.

TABLE, *showing the proportion of solid matter and water in 100 parts each of the following articles of diet.*

Designation.	Solid matter.	Water.	Designation.	Solid matter.	Water.
Wheat	87	13	Pork................	24	76
Peas................	87	13	Codfish..............	21	79
Rice	86	14	Blood	20	80
Beans...............	86	14	Trout................	19	81
Rye	86	14	Apples..............	18	82
Corn................	86	14	Pears	16	84
Oatmeal.............	74	26	Carrots.............	13	87
Wheat bread.........	51	49	Beets................	13	87
Mutton..............	29	71	Milk.................	13	87
Chicken.............	27	73	Oysters..............	13	87
Lean Beef	26	74	Cabbage.............	8	92
Eggs................	26	74	Turnips	7	93
Veal................	25	75	Water Melon.	5	95
Potatoes............	25	75	Cucumber.	3	97

WEIGHTS OF GRAIN, SEEDS, &c.

TABLE, *showing the weight of grain, seeds, &c., per bushel, as established by the Legislatures of the following States. The letter* m *indicates sold by measure.*

ARTICLES.	New-York.	Ohio.	Pennsylvania.	Indiana.	Wisconsin.	Iowa.	Illinois.	Michigan.	Connecticut.	Massachusetts.	Rhode-Island.	Kentucky.	New-Jersey.	Vermont.	Missouri.	Canada.
Wheat, lbs.	60	60	60	60	60	60	60	60	56	60		60	60	60	60	60
Rye,	56	56	56	56	56	56	54	56	56	56		56	56	56	56	56
Corn,	58	56	56	56	56	56	56	56	56	56		56	56	56	52	56
Oats,	32	32	32	32	32	35	32	32	28	30		33	30	32	m	34
Barley,	48	48	47	48	48	48	44	48		46		48	48	46	m	48
Buckwheat,	48		48	50	42	52	40	42	45	46		52	50	46	m	48
Clover seed,	60	64		60	60	60		60				60	64		m	60
Timothy seed,	44	42		45		45		m		m		45			m	48
Flax seed,	55	56		56		56		m		m		56	55		m	56
Hemp seed,	44			44		44										
Blue-grass seed,	14			14		14										
Apples, dried,	22	25			28	24		28								22
Peaches, dried,	32	33			28	33		28								22
Coarse salt,	56	50	85	50		50				70		50			50	56
Fine salt,	56	50	62	50		50				70		50			50	56
Potatoes,	60			60		60			60	60	60			60		
Peas,	60									60						60
Beans,	62	56		60		60				60		60				60
Castor Beans,	46			46		46										
Onions,	57			57		57				50	50					
Corn Meal,				50							50					
Mineral Coal,				70												

To reduce cubic feet to bushels, struck measure, divide the cubic feet by 56 and multiply by 45.

PROPORTION OF ALCOHOL IN LIQUORS.

TABLE, *showing the proportion of alcohol in* 100 *parts, each, of the following liquors.*

Designation.	Parts in 100.	Designation.	Parts in 100.
Scotch Whiskey	54.32	Sherry	19.17
Irish Whiskey	53.9	Claret	15.1
Rum	53.68	Champagne	13.8
Brandy	53.39	Gooseberry	11.84
Gin	51.6	Elder	8.79
Port	22.9	Ale	6.87
Madeira	22.27	Porter	4.2
Currant	20.55	Cider	9.8 to 5.2
Teneriffe	19.79		

Prof. Brande.

NUTRITIVE VALUE OF CERTAIN CROPS.

If we suppose an acre to yield the following quantities of the usually cultivated crops, the weight of dry starch and gum, of gluten, albumen, casein, &c., of oil or fat, and of saline matter, reaped in each crop, will be represented nearly by the following numbers:—

DESIGNATION.	Bushels.	lbs.	Husk or woody fibre.	Starch, sugar, and gum.	Gluten, albumen, and casein.	Oil.	Saline matter.
Wheat	25	1500	225	825	180	45	30
Barley	35	1800	270	1080	230	50	50
Oats	50	2100	420	1050	300	100	75
Peas	25	1600	130	800	380	54	48
Beans	25	1600	160	640	420	40	50
Indian Corn	30	1800	100	1260	220	130	80
Potatoes	12 tons	27000	1080	4800	540	45	240
Turnips	30 "	67000	1340	6000	1000	200	450
Wheat Straw	1⅓ "	3000	1500	900	40	80	150
Meadow Hay	1½ "	3400	1020	1360	240	120	220
Clover Hay	2 "	4500	1120	1800	420	200	400
Cabbage	20 "	45000	430	2300	1300	130	600

Johnston.

NOTE.—From the above table it appears that the acre which, by cropping with wheat, would yield a given weight of starch, sugar, and gum, would, when cropped with barley or oats, yield *one-fourth* more of these substances—with potatoes, about *four times* as much, and with turnips *eight times* the same quantity. In other words, the piece of ground which, when sown with wheat, will maintain one man, would support one and a quarter if sown with barley or oats, four with potatoes, and eight with turnips—*in so far as the nutritive power of these crops depends on the starch, sugar, and gum they contain.*

PERCENTAGE OF OIL IN SEEDS, GRAIN, &c.

Oil per cent. in different seeds, grain, &c.

	Oil per cent.		Oil per cent.
Linseed	11 to 22 say 17	Oats	5 to 8 say 6½
Hempseed	14 " 25 " 19	Indian corn	5 " 9 " 7
Rapeseed	40 " 70 " 55	Wheat bran	3 " 5 " 4
White mustard	36 " 38 " 37	Potatoes, turnips, and cabbage	1½
Sweet almond	40 " 54 " 47	Wheat-straw	2 " 3½ " 3
Bitter almond	28 " 46 " 37	Oat-straw	4
Turnip seed	40 " 50 " 45	Meadow hay	2 " 5 " 3½
Wheat flour	2 " 4 " 3	Clover hay	3 " 5 " 5
Barley	2 " 3 " 2½		

QUANTITIES OF SEED REQUIRED TO THE ACRE, &c.

TABLE, *showing the quantity of garden seeds required to plant a given space.*

Designation.	Space and quantity of seeds.
Asparagus	1 oz. produces 1000 plants, and requires a bed 12 ft. sq.
" Roots	1000 plant a bed 4 feet wide 225 feet long.
Eng. Dwarf Beans	1 quart plants from 100 to 150 feet of row.
French "	1 " " 250 or 350 feet of row.
Beans, pole, large	1 " " 100 hills.
" " small	1 " " 300 hills, or 250 feet of row.

Designation.	Space and quantity of seeds.
Beets	10 lbs. to the acre; 1 oz. plants 150 feet of row.
Broccoli and Kale	1 oz. plants 2,500 plants, and requires 40 sq. ft. of ground.
Cabbage	Early sorts same as brocoli, and require 60 sq. ft. ground.
Cauliflower	The same as cabbage.
Carrot	1 oz. to 150 of row.
Celery	1 oz. gives 7000 plants, and requires 8 sq. feet of ground.
Cucumber	1 oz. for 150 hills.
Cress	1 oz. sows a bed 16 feet square.
Egg Plant	1 oz. gives 2000 plants.
Endive	1 oz. gives 3000 plants, and requires 80 feet of ground.
Leek	1 oz. gives 2000 plants, and requires 60 feet of ground.
Lettuce	1 oz. " 7000 " and requires seed bed of 120 feet.
Melon	1 oz. for 120 hills.
Nasturtium	1 oz. sows 25 feet of row.
Onion	1 oz. " 200 " "
Okra	1 oz. " 200 " "
Parsley	1 oz. " 200 " "
Parsnip	1 oz. " 250 " "
Peppers	1 oz. gives 2500 plants.
Peas	1 quart sows 120 feet of row.
Pumpkin	1 oz. to 50 hills.
Radish	1 oz. to 100 feet.
Salsify	1 oz. to 150 feet of row.
Spinage	1 oz. to 200 feet of row.
Squash	1 oz. to 75 hills.
Tomato	1 oz. gives 2500 plants, requiring seed bed of 80 feet.
Turnip	1 oz. to 2000 feet.
Water Melon	1 oz. to 50 hills.

TABLE, *showing the quantity of seed required to the acre.*

Designation.	Quantity of seed.	Designation.	Quantity of seed.
Wheat	1¼ to 2 bush.	Broom Corn	1 to 1½ bush.
Barley	1½ to 2½ "	Potatoes	5 to 10 "
Oats	2 to 4 "	Timothy	12 to 24 quarts
Rye	1 to 2 "	Mustard	8 to 20 "
Buckwheat	¾ to 1¼ "	Herd Grass	12 to 16 "
Millet	1 to 1½ "	Flat Turnip	2 to 3 lbs.
Corn	¼ to 1 "	Red Clover	10 to 16 "
Beans	1 to 2 "	White Clover	3 to 4 "
Peas	2½ to 3½ "	Blue Grass	10 to 15 "
Hemp	1 to 1½ "	Orchard Grass	20 to 30 "
Flax	½ to 2 "	Carrots	4 to 5 "
Rice	2 to 2½ "	Parsnips	6 to 8 "

TABLE, *showing the quantity per acre when planted in rows or drills.*

Broom Corn	1 to 1½ bush.	Onions	4 to 5 lbs.
Beans	1½ to 2 "	Carrots	2 to 2½ "
Peas	1½ to 2 "	Parsnips	4 to 5 "
		Beets	4 to 6 "

DEPTH OF SOWING WHEAT.

Wheat may be sowed too shallow as well as too deep. The depth must vary with the soil. A thinner covering is required in a close, thick, heavy soil, than in one light, gravelly, and sandy. Experiments made with wheat give the following results:—

	Appeared above ground in	No. of plants that came up.
Seeds sown to the depth of............½ inch.	11 days.	7/8
" " " " ....1 "	12 "	all.
" " " " ....2 "	18 "	7/8
" " " " ....3 "	20 "	6/8
" " " " ....4 "	21 "	1/2
" " " " ....5 "	22 "	3/8
" " " " ....6 "	23 "	1/8

PROPORTIONS OF WEIGHT TO BULK.

TABLE, *showing the weight per cubic foot of various substances, and the number of cubic feet required to make a ton of each.*

Material.	Lbs. per cubic ft.	Cub. feet per ton.
METALS.		
Cast Iron	454	4.93
Wrought Iron	485	4.62
Steel	490	4.6
Copper, cast	549	4.08
Copper, wrought	557	4.02
Brass	524	4.03
Lead	709	3.15
Silver	654	
Tin	456	4.9
Gold	1203	
Zinc	439	5.
Platinum	1218	
Mercury	848	2.64
White Lead	198	11.
STONE, ETC.		
Granite	165	13.5
Limestone	165	13.5
Marble	171	13.1
Paving Stone	151	14.8
Sand Stone	130	17.
Brick	120	18.7
Chalk	174	12.8
Clay	125	18.

Material.	Lbs. per cubic ft.	Cub. feet per ton.
STONE, ETC.		
Glass	180	12.44
Sand	95	23.56
Slate	167	13.4
WOOD.		
Ash	48	46.
Beach	46	48.7
Cedar	35	64.
Elm	44	51.
Mahogany, Spanish	57	39.3
Oak, English	52	43.
White Oak, American	45	49.
Live Oak	70	32.
Pine, Pitch	43	51.6
" Yellow	38	59.
" White	34	66.
Poplar	46	48.
MISCELLANEOUS.		
Water, fresh	62.5	35.8
" salt	64.5	34.8
Air*	.07529	
Steam†	.03689	
Cork	15.	149.8
Olive oil	57.	39.8
Tallow	59.	

* At the level of the sea. † Not under pressure.

CORN—PORK.

According to the Patent Office Reports, and the results of numerous experiments, 1 bushel of corn weighing 56 lbs. will produce $10\frac{1}{2}$ lbs. of pork. Throwing off $\frac{1}{5}$ to come at the net weight, gives $8\frac{2}{5}$ lbs. of pork as the product of 1 bushel of corn, or 1 lb. of pork as the product of $6\frac{2}{3}$ lbs. of corn. $3\frac{4}{5}$ lbs. of cooked corn-meal makes 1 lb. of pork. Assuming that it requires $6\frac{2}{3}$ lbs. of corn to make 1 lb. of pork (exclusive of the labor of feeding and taking care of hogs), the relation which the price of corn bears to that of pork is exhibited in the following

TABLE, *showing the price of pork per lb. at different prices per bushel for corn.*

Corn per bush. Cents.	Pork per pound. Cents.	Corn per bush. Cents.	Pork per pound. Cents.
$12\frac{1}{2}$	1.50	38	4.52
15	1.78	40	4.76
17	2.	42	5.
20	2.38	45	5.35
22	2.62	50	5.95
25	2.96	55	6.54
30	3.57	60	7.14
33	3.92	65	7.74
35	4.	70	8.57

By reversing the above table we have the price of corn per bushel at different prices per lb. for pork. The use of the above table is obvious. For example, should corn be selling for 50 cents per bushel and pork for only 5 cents per lb., it would be most profitable to sell the corn; but should corn be selling for 40 cents per bushel and pork for 6 cents per lb., it would be most profitable to reduce the corn to pork, and sell the latter.

To find the price of pork per lb., taking the price of corn per bushel as the datum.

RULE.—Divide the price of a bushel of corn by 8.40 (the number of lbs. of pork produced by a bushel of corn), and the quotient will be the answer.

EXAMPLE.—When corn is 20 cents per bushel, what should be the price of pork per lb.?

SOLUTION.—20.00 cents, ÷8.40 lbs., =2.38 cents. *Ans.*

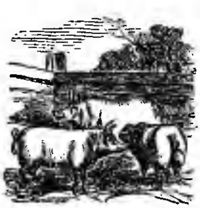
To find the price of corn per bushel, taking the price of pork per lb. as the datum.

RULE.—Multiply the price of a lb. of pork by 8.40 (the number of lbs. of pork produced by a bushel of corn), and the product will be the answer.

EXAMPLE.—What should be the price of corn per bushel when pork is selling at 4½ cents per lb.

SOLUTION.—4.50 cents, × 8.40 lbs.,=37.8 cents. *Ans.*

NOTE.—The foregoing table and rules must not be taken as *invariably* correct. It requires but little reflection to satisfy the farmer that the proportions and results exhibited by them must be influenced by many conditions and causes, such as the sample of corn used, the constitution and breed as well as the age of the animal, its condition, powers of digestion, habits, health, &c. The very nature of the subject precludes the possibility of *exactly* defining the results and proportions. At best we can only have some *general*, *average* results and rules. The foregoing is deemed a safe general average.



To keep hens in winter.

Provide—

1. A comfortable roost;
2. Plenty of sand, gravel and ashes, *dry*, to play in;
3. A box of lime;
4. Boiled meat, chopped fine, every two or three days;

5. Corn and oats, which will be best if boiled tender;
6. All the crumbs and potato parings;
7. Water, neither cold nor blood-warm.

This treatment has proved quite successful in a great many cases where the formula has been strictly adhered to, and hens which without it gave no eggs, with it immediately laid one each, on an average, every two days.

TABLE, *showing the period of reproduction and gestation of domestic animals.*

DESIGNATION.	Proper age for reproduction.	Period of the power of reproduction in years.	No. of Females for one Male.	PERIOD OF GESTATION AND INCUBATION		
				Shortest period, days.	Mean period, days.	Longest period, days.
Mare, ...	4 years.	10 to 12		322	347	419
Stallion......	5 "	12 to 15	20 to 30			
Cow, ...	3 "	10 to 14		240	283	321
Bull, ...	3 "	8 to 10	30 to 40			
Ewe, ...	2 "	6		146	154	161
Ram, ...	2 "	7	40 to 50			
Sow, ...	1 "	6		109	115	143
Boar, ...	1 "	6	6 to 10			
She Goat,....	2 "	6		150	156	163
He Goat, ...	2 "	5	20 to 40			
She Ass,.....	4 "	10 to 12		365	380	391
He Ass.......	5 "	12 to 15				
She Buffalo,..		8		281	308	335
Bitch, ...	2 "	8 to 9		55	60	63
Dog.	2 "	8 to 9				
She Cat,.....	1 "	5 to 6		48	50	56
He Cat.......	1 "	9 to 10	5 to 6			
Doe Rabbit..	6 months	5 to 6		20	28	35
Buck Rabbit,.	6 "	5 to 6	30			
Cock, ...	6 "	5 to 6	12 to 15			
Hen, ...		3 to 5		19	21	24
Turkey, ...				24	26	30
Duck, ...				28	30	32
Goose, ...				27	30	33
Pigeon,......				16	18	20
Pea Hen.				25	28	30
Guinea Hen..				20	23	25
Swan,........				40	42	45

Growth and life of animals.

Man	grows	for	20	years,	and lives	90 or 100	years.
The Camel	"	"	8	"	" "	40	"
The Horse	"	"	5	"	" "	25	"
The Ox	"	"	4	"	" "	15 to 20	"
The Lion	"	"	4	"	" "	20	"
The Dog	"	"	2	"	" "	12 to 14	"
The Cat	"	"	1½	"	" "	9 or 10	"
The Hare	"	"	1	"	" "	8	"
The Guinea pig		"	7	months,	and lives	6 or 7	"

A Table *showing at one view when Forty Weeks (the period of gestation in a cow) will expire, from any day throughout the year.*

Jan.	Oct	Feb.	Nov	March	Dec	April.	Jan	May.	Feb.	June.	March.
1	8	1		1	6	1	6	1	5	1	8
2	9	2	9	2	7	2	7	2	6	2	9
3	10	3	10	3	8	3	8	3	7	3	10
4	11	4	11	4	9	4	9	4	8	4	11
5	12	5	12	5	10	5	10	5	9	5	12
6	13	6	13	6	11	6	11	6	10	6	13
7	14	7	14	7	12	7	12	7	11	7	14
8	15	8	15	8	13	8	13	8	12	8	15
9	16	9	16	9	14	9	14	9	13	9	16
10	17	10	17	10	15	10	15	10	14	10	17
11	18	11	18	11	16	11	16	11	15	11	18
12	19	12	19	12	17	12	17	12	16	12	19
13	20	13	20	13	18	13	18	13	17	13	20
14	21	14	21	14	19	14	19	14	18	14	21
15	22	15	22	15	20	15	20	15	19	15	22
16	23	16	23	16	21	16	21	16	20	16	23
17	24	17	24	17	22	17	22	17	21	17	24
18	25	18	25	18	23	18	23	18	22	18	25
19	26	19	26	19	24	19	24	19	23	19	26
20	27	20	27	20	25	20	25	20	24	20	27
21	28	21	28	21	26	21	26	21	25	21	28
22	29	22	29	22	27	22	27	22	26	22	29
23	30	23	30	23	28	23	28	23	27	23	30
24	31		Dec	24	29	24	29	24	28	24	31
	Nov	24	1	25	30	25	30		March		April.
25	1	25	2	26	31	26	31	25	1	25	1
26	2	26	3		Jan		Feb	26	2	26	2
27	3	27	4	27	1	27	1	27	3	27	3
28	4	28	5	28	2	28	2	28	4	28	4
29	5	29	6	29	3	29	3	29	5	29	5
30	6			30	4	30	4	30	6	30	6
31	7			31	5			31	7	31	7

Table continued.

July.	April	Aug.	May.	Sept.	June.	Oct.	July.	Nov.	Aug	Dec.	Sept
1	7	1	8	1	8	1	8	1	8	1	7
2	8	2	9	2	9	2	9	2	9	2	8
3	9	3	10	3	10	3	10	3	10	3	9
4	10	4	11	4	11	4	11	4	11	4	10
5	11	5	12	5	12	5	12	5	12	5	11
6	12	6	13	6	13	6	13	6	13	6	12
7	13	7	14	7	14	7	14	7	14	7	13
8	14	8	15	8	15	8	15	8	15	8	14
9	15	9	16	9	16	9	16	9	16	9	15
10	16	10	17	10	17	10	17	10	17	10	16
11	17	11	18	11	18	11	18	11	18	11	17
12	18	12	19	12	19	12	19	12	19	12	18
13	19	13	20	13	20	13	20	13	20	13	19
14	20	14	21	14	21	14	21	14	21	14	20
15	21	15	22	15	22	15	22	15	22	15	21
16	22	16	23	16	23	16	23	16	23	16	22
17	23	17	24	17	24	17	24	17	24	17	23
18	24	18	25	18	25	18	25	18	25	18	24
19	25	19	26	19	26	19	26	19	26	19	25
20	26	20	27	20	27	20	27	20	27	20	26
21	27	21	28	21	28	21	28	21	28	21	27
22	28	22	29	22	29	22	29	22	29	22	28
23	29	23	30	23	30	23	30	23	30	23	29
24	30	24	31		July.	24	31	24	31	24	30
	May.		June	24	1		Aug.		Sept.		Oct.
25	1	25	1	25	2	25	1	25	1	25	1
26	2	26	2	26	3	26	2	26	2	26	2
27	3	27	3	27	4	27	3	27	3	27	3
28	4	28	4	28	5	28	4	28	4	28	4
29	5	29	5	29	6	29	5	29	5	29	5
30	6	30	6	30	7	30	6	30	6	30	6
31	7	31	7			31	7			31	7

AGE OF ANIMALS.

To find the age of a horse.

The colt is born with 12 grinders. When 4 front teeth have made their appearance the colt is 12 days old, and when the next 4 appear it is four weeks old. When the corner teeth appear it is eight months old, and when the latter have attained the height of the front teeth it is a year old. The two year old colt has the kernel (the dark substance in the middle of the tooth's crown) ground or worn out of all the front teeth. In the third year the middle front teeth are being shifted, and when three years old these are substituted for the horse teeth. In the fourth year the next 4 are shifted, and in the fifth year the corner teeth are shifted. In the sixth year the kernel is worn out of the middle front teeth, and the bridle teeth have now attained their full growth. At seven years a hook has been formed on the corner teeth of the upper jaw: the kernel of the teeth next at the middle is worn out, and the bridle teeth begin to wear off. At eight years of age the kernel is worn out of all the lower front teeth, and begins to decrease in the middle upper fronts. In the ninth year the kernel has wholly disappeared from the upper middle front teeth, the hook on the corner teeth has increased in size, and the bridle teeth loose their point. In the tenth year the kernel has worn out of the teeth next to the middle fronts of the upper jaw, and in the eleventh year the kernel has entirely disappeared from the corner teeth of the same jaw. At twelve years the crowns of all the front teeth in the lower jaw have become triangular, and the bridle teeth are much worn down. As the horse advances in age the gums shrink away from the teeth, which appear long and narrow, and the kernels become changed into darkish points. Gray hairs increase in the forehead and the chin becomes angular.

A modification of the foregoing, much more scientific or systematic, and probably quite as reliable, is the classification of Pessina, a distinguished veterinary surgeon of Germany.

Its principles may be distinctly understood by reference to the accompaning cuts, A, B, C, and D.

A, represents the corner tooth of a young horse; the oth-

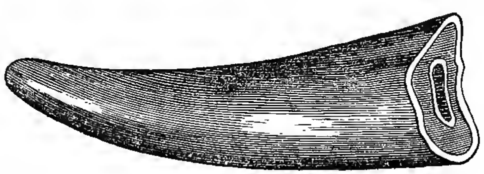


FIG. A.

er nippers vary very little from this one in their construction and form.

The top of the tooth is long from side to side, and the extreme lower end is long from front to rear. The manner in which the shape changes as we go farther down the tooth is represented in figure B, where cross sections at different sections are shown.

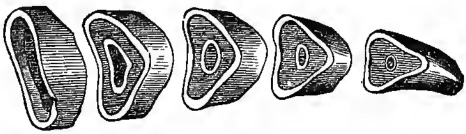


FIG. B.

The horse's tooth is worn away by use, and its upper surface assumes the form of these different sections consecutively, according to the extent to which it has been worn off. Of course, this only forms a general rule by which to judge of the age of a horse. Cribbiters, horses feeding chiefly on very old dry hay, and oats mixed with grit, and horses which are continually gnawing their mangers, will have their teeth worn away faster than will those which are fed on grass and moistened, cut, and ground feed, and which keep their teeth to themselves when they are not eating.

Pessina's table of indications of age is correct for the average of horses, and in all cases is sufficiently so for general purposes.

We quote the following from Herbert's hints to horsekeepers:—

"At *five* years the corners are up even with the other teeth; the mark is entirely worn out from the middle nippers, and partly worn from the next pair (fig. C).

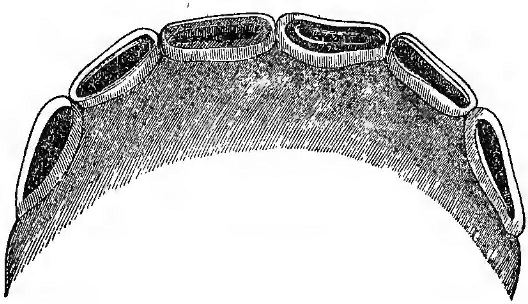


Fig. C.

"At *six* years the mark is almost gone from the second pair, and the *outer edge* of the corner teeth is worn down.

"At *seven* years the mark is entirely gone from the second pair, and the edges of the corner teeth are worn somewhat flat.

"At *eight* years the teeth of the lower jaw are worn entirely flat, the mark having disappeared from all of them. The form of the surface of the tooth has become oval, and the central enamel is long from side to side, and is near to the front of the tooth.

"At *nine* years the middle nippers are rounded on the inner side, the oval of the second pair and of the corner teeth becomes broader, the central enamel is nearer to the inner side, and the marks have disappeared from the teeth of the upper jaw.

"At *ten* years the second pair are rounded on the inner side, and the central enamel is very near to the inner side.

"At *eleven* years the corner teeth are rounded, and the central enamel becomes very narrow.

"At *twelve* years the nippers are all rounded, and the central enamel has entirely disappeared from the lower jaw; but it may still be seen in the upper jaw.

"At *thirteen* years the middle nippers commence to assume a triangular form in the lower jaw, and the central enamel has entirely disappeared from the corner teeth of the upper jaw.

"At *fourteen* years the middle nippers have become trigular, and the second pair are assuming that form; the central enamel has diminished in the middle nippers of the upper jaw.

"At *fifteen* years the second pair have become triangular (fig. D); the central enamel is still visible in the upper jaw.

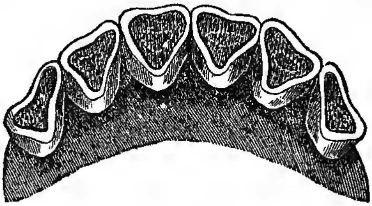


FIG. D.

"At *sixteen* years all of the teeth in the lower jaw have become triangular, and the central enamel is entirely removed from the second pair in the upper jaw.

"At *seventeen* years the sides of the triangle of the middle nippers are all of the same length; the central enamel has entirely disappeared from the upper teeth.

"At *eighteen* years the sides of the triangle of the middle nippers are longer at the sides of the teeth than in front.

"At *nineteen* years the middle nippers become flattened from side to side and long from front to rear.

"At *twenty* years the second pair assume the same form.

"At *twenty-one* years all of the teeth of the lower jaw have become flattened from side to side; the greatest diameter having become exactly the reverse of what it was in youth."

TO FIND THE AGE OF CATTLE.

In the *cow* the horn is often regarded as affording, by the number of its rings, a criterion of the animal's age. The horn of a heifer remains smooth or unprotuberant till the expiration of the second year of its life. A circle of thicker matter, or sort of horny button then begins to be formed, which is completed in another year; the next year this circle or button moves from the head, or is impelled by the cylindric growth of the horn, and another circle or button begins to be formed, which after another twelve-month is also impelled outward, and so on year after year of the whole life of the animal, so that by counting the number of rings on the cow's horns, and adding 2 to their number, its age is arrived at.

The rings on the *bull's* horns do not begin to appear until he is five years old, so that to arrive at his age we must add 5 to the number of rings. The horn of the ox is so very strongly modified by his peculiar condition, as to be totally unlike that of the bull, the rings scarcely appearing at all.

The above rule would enable one to tell the age of the animal with unerring certainty, were the growth of the horns in each animal uniform and the rings distinct, which is not always the case; the rings often being confused and indistinct, and the growth of the horns varying in different animals. Besides, knavish cattle dealers often rasp off several of the rings of old and unsalable cows, and so smooth the rest of the horns as to make them look in keeping with their pretensions.

A safer rule is afforded by the teeth. At birth the two centre teeth (front) protrude through the gum; at the end of the second week the second pair appear; at the end of the third week the third pair, and at the end of the fourth week the fourth and last pair. The wearing of these teeth now constitntes the only guide for the next three months, at the expiration of which time all these (which are called the "milk teeth") begin to diminish in size and shrink away from each other, which process continues until the animal is two years old, when the new teeth begin to push out the slender remnants of the old and shrunken ones. At the end of the second year the first two permanent teeth appear in front; at three years the second pair are well up: at four the third pair, and at five years the fourth and last pair, have appeared, and the central pair are beginning to become worn down: at six years the last pair are full sized: at seven years the dark line with bony boundery appears in all the teeth, and a broad circular mark appears within the central pair: at eight years this mark appears in all the teeth: at nine years a process of absorption and shrinkage, similar to that which reduced the first teeth, begins to take place in the central pair; at ten it begins with the second pair; at eleven with the third pair, at twelve with the fourth pair. The age of the animal, after this period is attained, is determined by the degree of shrinkage and wearing away of all the teeth in the order of their appearance, until the fifteenth year, when scarcely any teeth remain.

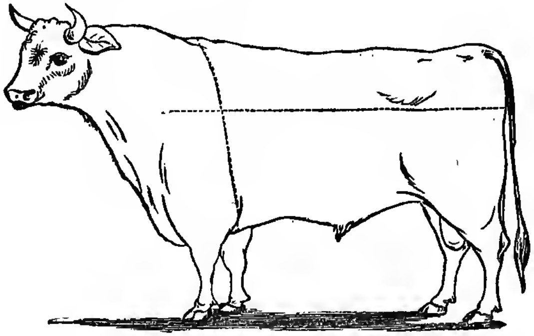
To ascertain the age of sheep.

The age of sheep may be known by the front teeth, which are 8 in number, and appear the first year all of a size. In the second year the two middle ones fall out and are supplanted by two large ones. During the third year a small tooth appears on each side. In the fourth year the large teeth are six in number. In the fifth year all the front teeth are large, and in the sixth year the whole begin to get worn.

To tell the age of goats.

The age of goats is ascertained by their teeth in the same manner that of the sheep is, and by the annular rings on their horns.

COMPUTE WEIGHT OF CATTLE.



For cattle of a girth of from 5 to 7 feet, allow 23 lbs. to the superficial foot.

For cattle of a girth of from 7 to 9 feet, allow 31 lbs. to the superficial foot.

For small cattle and calves of a girth of from 3 to 5 feet, allow 16 lbs. to the superficial foot.

For pigs, sheep, and all cattle measuring less than 3 feet girth, allow 11 lbs. to the superficial foot.

Rule.—Ascertain the girth in inches back of the shoulders, and the length in inches from the square of the buttock to a point even with the point of the shoulder-blade. Multiply the girth by the length, and divide the product by 144 for the superficial feet, and then multiply the superficial feet by the number of lbs. allowed as above for cattle of different girths, and the product will be the number of lbs. of beef, veal, or pork in the four quarters of the animal. To find the number of stone divide the number of lbs. by 14.

Example.—What is the computed weight of beef in a steer, whose girth is 6 feet 4 inches, and length 5 feet 3 inches?

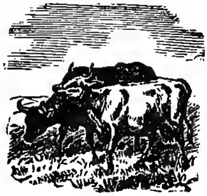
Solution.—76 inches, girth, × 63 inches, length, =4788 ÷ 144=33¼ square feet, × 23=764¾ lbs., or 54⅝ stone. *Ans.*

Note.—When the animal is but half fattened a deduction of 14 lbs. in every 280, or one stone in every 20 must be made; and if very fat, one stone for every 20 must be added.

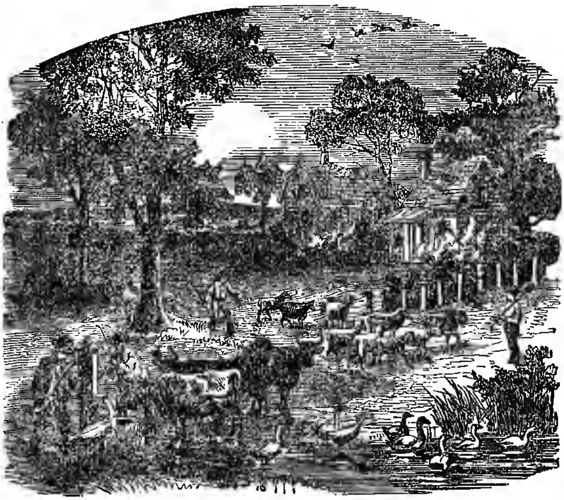
Where great numbers of cattle are annually bought and sold under circumstances that forbid ascertaining their weight with positive accuracy, the compute weight may be thus taken with approximate exactness—at least with as much accuracy as is necessary in the aggregate valuation of stock. No rules or tables can, however, be at all times implicitly relied on, as there are many circumstances connected with the build of the animal, the mode of fattening, its condition, breed, &c., that will influence the measurement, and consequently the weight. A person skilled in taking the compute weight of stock soon learns, however, to make allowances for all these circumstances.

The following table is compiled from two English works on the subject:—

Girth. ft.	in.	Length. ft.	in.	Renton's Table. stone.	lb.	Cary's Table. stone.	lb.
5	0	3	6	21	0	21	00
5	0	4	0	24	0	24	00
5	6	3	9	27	1	27	00
5	6	4	0	34	4	34	07
6	0	4	6	38	8	38	11
6	0	5	0	43	1	43	00
6	6	4	6	45	9	45	07
6	6	4	9	48	0	48	00
7	0	5	6	64	6	64	07
7	0	6	0	70	5	70	03
8	0	6	6	99	8	99	12
8	0	7	0	107	5	107	06



FOOD OF ANIMALS.



TABLE, *showing the comparative difference between good hay and the substances mentioned below, as food for stock—being the results of experiments.*

10 lbs. of hay are equal to		10 lbs. of hay are equal to	
8 to 10 lbs.	clover hay.	30 to 35 lbs.	mangold wurtzel.
45 to 50 "	green clover.	45 to 50 "	turnips.
40 to 50 "	wheat straw.	20 to 30 "	cabbage.
20 to 40 "	barley straw.	3 to 5 "	peas and beans.
20 to 40 "	oat straw.	5 to 6 "	wheat.
10 to 15 "	pea straw.	5 to 6 "	barley.
20 to 25 "	potatoes.	4 to 7 "	oats.
25 to 30 "	carrots (red).	5 to 7 "	Indian corn.
40 to 45 "	" (white).	2 to 4 "	oil cake.

NOTE.—In the use of the above table much of course will depend upon the quality of the sample, the age and constitution of the animal, and the form in which the food is administered. Much also depends upon a *change of food*, and a *due admixture* of the different kinds.

TABLE, *showing the comparative difference between good hay and the articles mentioned below, as food for stock—being the mean of experiment and theory.*

100 lbs. of hay are equal to		100 lbs. of hay are equal to	
275 lbs.	green Indian corn.	54 lbs.	rye.
442 "	rye straw.	46 "	wheat.
360 "	wheat "	59 "	oats.
164 "	oats "	45 "	peas and beans mixed.
180 "	barley "	64 "	buckwheat.
153 "	pea "	57 "	Indian corn.
200 "	buckwheat straw.	68 "	acorns.
201 "	raw potatoes.	105 "	wheat bran.
175 "	boiled "	109 "	rye "
339 "	mangold wurtzel.	167 "	wheat, pea, and oat chaff.
504 "	turnips.	179 "	rye and barley, mixed.
300 "	carrots.		

NOTE.—It must be borne in mind that the nutritive effects of food upon the animal are varied by numberless causes, such as the animal's power of digestion and appropriation, its condition, shelter, air, water, exercise, &c. But all else being equal, the nutritive qualities of the articles mentioned are in the above proportions.

The results of numerous experiments, reported by individuals and Agricultural Associations, show, that each 100 lbs. of live weight of the animal requires of hay or its equivalent, per day, as follows:—

Working horses	3.08 lbs.
" oxen	2.40 "

Fatting oxen		5.00 lbs.
" " when fat		4.00 "
Milch cows	from 2.25 to	2.40 "
Dry "		2.42 "
Young growing cattle		3.08 "
Steers		2.84 "
Pigs		3.60 "
Sheep		3.00 "
Elephant*		3.12 "

In the ox, the daily loss of muscle or tissue requires that he should consume 20 to 24 ounces of gluten or albumen, which will be supplied by any of the following weights of vegetable food:—

Meadow hay	20 lbs	Turnips	120 lbs.
Clover hay	16 "	Cabbage	70 "
Oat straw	110 "	Wheat or other white grain.	11 "
Pea straw	12 "	Beans or peas	6 "
Potatoes	60 "	Oil cake	4 "
Carrots	70 "		

Or instead of any one of these, a mixture of several may be given with the best results. But if the due proportion of nitrogenous food be not given, the ox will lose his muscular strength and will generally fail. So with growing and fattening stock of every description; the proportion of each of the kinds of food required by the animal must, in practice, be adjusted to the purpose for which it is fed.

It is not strictly correct that this or that kind of vegetable is more fitted to sustain animal life simply because of the large proportion of *nitrogen* or *gluten* it contains; it is wisely provided, however, that, along with this nitrogen, all

* Mr. Barnum's elephant, weighing 4700 lbs., was found to consume 100 lbs. of hay and 1 bushel of oats per day.

plants contain a certain proportion of starch or sugar, and of saline or earthy matter—all of which are required in a mixture which will most easily sustain an animal in a healthy condition ; so that the proportion of nitrogen in a substance may be considered as a rough practical index of the proportion of the more important saline and earthy ingredients also.

TABLE, *showing the effects produced by an equal quantity of the following substances, as food for sheep.*

Lbs.	Designation.	Increased weight of living animal in Lbs.	Produced Wool. Lbs.	Produced Tallow. Lbs.
1000	potatoes, raw with salt.........	46½	6½	12½
"	" " without salt......	44	6½	11½
"	mangel-wurtzel, raw..........	38½	5¼	6½
"	wheat..........................	155	14	59½
"	oats...........................	146	10	42½
"	barley.........................	136	11¼	60
"	peas...........................	134	14½	41
"	rye, with salt.................	133	14	35
"	" without salt.............	90	12	43
"	corn meal, wet................	129	13½	17½
"	buckwheat.....................	120	10	33

NOTE.—The above are the results of numerous experiments by De Raumer.

DECREASE AND EXPECTATION OF LIFE.

TABLE, *showing the decrement and expectation of human life.*

Age.	Persons Living.	Decrement of Life.	Expectation of Life in Years and Decimals.	Age	Persons Living.	Decrement of Life.	Expectation of Life in Years and Decimals.	Age.	Persons Living.	Decrement of Life.	Expectation of Life in Years and Decimals.
At birth.	4893	1264	28.17	34	1772	38	30.24	68	772	37	12.43
1	3629	274	"	85	1737	35	23.22	69	735	37	"
2	3356	188	"	36	1702	35	"	70	698	37	10.06
8	3167	132	"	87	1667	35	"	71	601	37	"
4	3035	84	"	38	1632	35		72	624	37	"
5	2951	58	40.87	39	1597	85	"	73	587	37	"
6	2893	55	"	40	1562	35	26.04	74	549	37	"
7	2838	47	"	41	1527	35	"	75	511	37	7.83
8	2791	40	"	42	1492	35	"	76	474	37	"
9	2751	36	"	43	1457	35	"	77	437	37	"
10	2715	28	39.27	44	1423	34	"	78	400	37	"
11	2687	27	"	45	1396	27	23.92	79	363	37	"
12	2660	27	"	46	1369	27	"	80	326	35	5.85
13	2633	27	"	47	1342	27	"	81	2)1	34	"
14	2606	27	"	48	1315	27	"	82	257	34	"
15	2579	42	36.10	49	1810	27	"	83	223	31	"
16	2537	43	"	50	1288	27	21.16	81	1-9	34	"
17	2494	43	"	51	1261	27	"	85	155	21	4.57
18	2451	43	"	52	1234	27	"	86	134	21	"
19	2408	43	"	63	1207	27	"	87	113	21	"
20	2365	43	34.21	54	1180	27	"	88	92	20	"
21	2322	42	"	55	1153	27	18.25	89	72	20	"
22	2280	42	"	56	1126	27	"	90	52	8	3.73
23	2238	42	"	57	1099	27	"	91	44	7	"
24	2196	42	"	58	1072	27	"	92	37	7	"
25	2154	40	32.32	59	1045	27	"	93	30	7	"
26	2114	38	"	60	1018	27	15.43	94	23	7	"
27	2076	38	"	61	991	27	"	95	16	6	1.62
28	2038	38	"	62	964	27	"	96	10	5	"
29	2000	38	"	63	937	27	"	97	5	3	"
30	1962	38	30.24	64	910	27	"	98	2	1	"
31	1924	38	"	65	883	37	12.43	99	1	1	"
32	1886	38	"	66	846	37	"				
33	1848	38	"	67	809	37	"				

The above table, originally compiled by Dr. Wiggleworth, of New England, after many years of careful observation and statistical research, exhibits the average yearly decrease of life out of a given number born, and the expectation of reaching a certain age deduced from that decrease as the *datum*. Among the many similar tables that have been constructed, it is perhaps the most accurate. It received the cautious scrutiny and revision of the Supreme Court of Massachusetts, and was adopted by it (*see Easterbrook vs. Hopgood*, 10 *Mass. Reports*, 313) as the rule in estimating the value of life estates.

Explanation.—Opposite the age of the individual, under the column headed "Expectation of Life, &c.," will be found the additional nnmber of years he may reasonably expect to live. Thus a man 40 years of age may reasonably expect to live 26.04 years longer.

For the purpose of comparison with observations in Europe, St. Maur's Table is subjoined, taken from observations in Paris and the country around it.

St. Maur's Table.

Of 24,000 born

17,540	attain to	2	years.		9,544	attain to	30	years.	
15,162	"	" 3	"		8,770	"	" 35	"	
14,177	"	" 4	"		7,729	"	" 40	"	
13,477	"	" 5	"		7,008	"	" 45	"	
12,968	"	" 6	"		6,197	"	" 50	"	
12,562	"	" 7	"		5,375	"	" 55	"	
12,255	"	" 8	"		4,564	"	" 60	"	
12,015	"	" 9	"		3,450	"	" 65	"	
11,861	"	" 10	"		2,544	"	" 70	"	
11,405	"	" 15	"		1,507	"	" 75	"	
10,909	"	" 20	"		807	"	" 80	"	
10,259	"	" 25	"		291	"	" 85	"	

103	attain	to	90	years.	
71	"	"	91	"	
63	"	"	92	"	
47	"	"	93	"	
40	"	"	94	"	
33	"	"	95	"	
23	attain	to	96	years.	
18	"	"	97	"	
16	"	"	98	"	
8	"	"	99	"	
6 or 7	"	"	100	"	

EXPLANATION.—To ascertain by the above table what probability there is that a man of a given age will attain to any other age, make the number opposite the latter age the numerator and the number opposite the former age the denominator, and the fraction will express the probability sought for.

EXAMPLE.—What probability is there that a man of 30 will attain the age of 70 years?

SOLUTION.—Opposite 70 find 2,544 = 318
" 30 " 9,544 = 1193 *Ans.* That is to say, he has 318 chances out of 1193 of living to 70.

COMPOUND INTEREST.

TABLE, *showing the amount of* $1 *for any number of years from* 1 *to* 24, *at* 5 *and* 6 *per cent., compound interest.*

Years.	5 per cent.	6 per cent.	Years.	5 per cent.	6 per cent.
1	1.05	1.06	13	1.88564	2.13292
2	1.1025	1.1236	14	1.97993	2.26090
3	1.15763	1.19101	15	1.07892	2.39655
4	1.21550	1.26247	16	1 18287	2.54035
5	1.27628	1.33822	17	1.29201	2.69277
6	1.34009	1.41851	18	1.40661	2.85433
7	1.40710	1.50363	19	1.52695	3.02559
8	1.47745	1.59384	20	1.65329	3.20713
9	1.55132	1.68947	21	1.78596	3.39956
10	1.62889	1.79084	22	1.92526	3.60353
11	1.71033	1.89829	23	1.07152	3.81974
12	1.79585	2.01219	24	1.22509	4.04893

Explanation.—Opposite the number of years in the column under the rate per cent., will be found the amount of $1, with the compound interest included for the time given. Should the amount of any given sum with the compound interest at a given rate per cent. for a given time be required, multiply the amount found in the column under the given rate per cent., and opposite the given time, by the sum at interest so given, and the product will be the answer.

Example.—What will be the amount of $150 at compound interest at the rate of 5 per cent. for 10 years?

Solution.—1.62889 × 150 = $244.33.35. *Ans.*

ANNUITIES.

Table, *showing the present worth of* $1 *annuity at* 5 *and* 6 *per cent. compound interest for any number of years from* 1 *to* 34.

Year.	5 per cent.	6 per cent.	Years.	5 per cent.	6 per cent.
1	0.95238	0.94339	18	11.68958	10 82760
2	1.85941	1.83339	19	12.08532	11.15811
3	2.72325	2.67301	20	12.46221	11.46992
4	3.54595	3.46510	21	12.82115	11.76407
5	4.3 948	4.21236	22	13.16300	12.04158
6	5.07569	4.91732	23	13.48807	12.30338
7	5.78637	5.58238	24	13.79864	12.55035
8	6.46321	6.20979	25	14 09394	12.78335
9	7.10782	6.80169	26	14.37518	13.00316
10	7.72173	7.36008	27	14.64303	13.21053
11	8.30641	7.88687	28	11.89813	13.40616
12	8.86325	8.38384	29	15.14107	13.59072
13	9.39357	8.85268	30	15.37245	13.76483
14	9.89864	9.29498	31	15.59281	13.92908
15	10.37966	9.71225	32	15.80268	14.08398
16	10.83777	10.10589	33	16.00255	14.22917
17	11.27407	10.47726	34	16.19290	14.36613

For explanation and example see Compound Interest above.

For convenience in finding the interest from one to $5000 from one to 2000 days, at 6 or 7 per cent., we give the following

TABLE.*

$		1 da	2	3	4	5	6	7	8	9	10	20	30	40	50	60	70	80	90	100	200
1	6 per ct.			.000	.001	.001	.001	.001	.001	.001	.002	.003	.005	.007	.008	.010	.012	.013	.015	.017	.033
	7 per ct.			.001	.001	.001	.001	.001	.002	.002	.002	.004	.006	.008	.010	.012	.014	.016	.017	.019	.039
2		.000	.001	.001	.001	.002	.002	.002	.003	.003	.003	.007	.010	.013	.017	.020	.023	.027	.030	.033	.067
		.000	.001	.001	.002	.002	.002	.003	.003	.003	.004	.008	.012	.016	.019	.023	.027	.031	.035	.039	.078
3		.000	.001	.001	.002	.002	.003	.003	.004	.004	.005	.010	.015	.020	.025	.030	.035	.040	.045	.050	.100
		.001	.001	.002	.002	.003	.003	.004	.005	.005	.006	.012	.017	.023	.029	.035	.041	.047	.052	.058	.117
4		.001	.001	.002	.003	.003	.004	.005	.005	.006	.007	.013	.020	.027	.033	.040	.047	.053	.060	.067	.133
		.001	.002	.002	.003	.004	.005	.005	.006	.007	.008	.016	.023	.031	.039	.047	.054	.062	.070	.078	.156
5		.001	.002	.002	.003	.004	.005	.006	.007	.007	.008	.017	.025	.033	.042	.050	.058	.067	.075	.083	.167
		.001	.002	.003	.004	.005	.006	.007	.008	.009	.010	.019	.029	.039	.049	.058	.068	.078	.087	.097	.194
6		.001	.002	.003	.004	.005	.006	.007	.008	.009	.010	.020	.030	.040	.050	.060	.070	.080	.090	.100	.200
		.001	.002	.003	.005	.006	.007	.008	.009	.010	.012	.023	.035	.047	.058	.070	.082	.093	.105	.117	.223
7		.001	.002	.003	.005	.006	.007	.008	.009	.010	.012	.023	.035	.047	.058	.070	.082	.093	.105	.117	.233
		.001	.003	.004	.005	.007	.008	.010	.011	.012	.014	.027	.041	.054	.068	.082	.095	.109	.122	.136	.272
8		.001	.003	.004	.005	.007	.008	.009	.011	.012	.013	.027	.040	.053	.067	.080	.093	.107	.120	.133	.267
		.002	.003	.005	.006	.008	.009	.011	.012	.014	.016	.031	.047	.062	.078	.093	.109	.124	.140	.156	.311
9		.001	.003	.004	.006	.007	.009	.010	.012	.013	.015	.030	.045	.060	.075	.090	.105	.120	.135	.150	.300
		.002	.003	.005	.007	.009	.010	.012	.014	.016	.017	.035	.052	.070	.087	.105	.122	.140	.157	.175	.350
10		.002	.003	.005	.007	.008	.010	.012	.013	.015	.017	.033	.050	.067	.083	.100	.117	.133	.150	.167	.333
		.002	.004	.006	.008	.010	.012	.014	.016	.017	.019	.039	.058	.078	.097	.117	.135	.156	.175	.194	.389
20		.003	.007	.010	.013	.017	.020	.023	.027	.030	.033	.067	.100	.133	.167	.200	.233	.267	.300	.333	.667
		.004	.008	.012	.016	.019	.023	.027	.031	.035	.039	.078	.117	.156	.194	.233	.272	.311	.350	.389	.778

30	.005	.010	.015	.020	.025	.030	.035	.040	.045	.050	.100	.150	.200	.250	.300	.350	.400	.450	.500	1.000
	.006	.012	.017	.023	.029	.035	.041	.047	.052	.058	.117	.175	.233	.292	.350	.408	.467	.525	.583	1.167
40	.007	.013	.020	.027	.033	.040	.047	.053	.060	.067	.133	.200	.267	.333	.400	.467	.533	.600	.667	1.333
	.008	.016	.023	.031	.039	.047	.054	.062	.070	.078	.156	.233	.311	.389	.467	.544	.622	.700	.778	1.556
50	.008	.017	.025	.033	.042	.050	.058	.067	.075	.083	.167	.250	.333	.417	.500	.583	.667	.750	.833	1.667
	.010	.019	.029	.039	.049	.058	.068	.078	.087	.097	.194	.292	.389	.486	.583	.681	.778	.875	.972	1.944
60	.010	.020	.030	.040	.050	.060	.070	.080	.090	.100	.200	.300	.400	.500	.600	.700	.800	.900	1.000	2.000
	.012	.023	.035	.047	.058	.070	.082	.093	.105	.117	.233	.350	.467	.583	.700	.817	.933	1.050	1.167	2.333
70	.012	.023	.035	.047	.058	.070	.082	.093	.105	.117	.233	.350	.467	.583	.700	.817	.933	1.050	1.167	2.333
	.014	.027	.041	.054	.068	.082	.095	.109	.122	.136	.272	.408	.544	.681	.817	.953	1.089	1.225	1.361	2.722
80	.013	.027	.040	.053	.067	.080	.093	.107	.120	.133	.267	.400	.533	.667	.800	.933	1.067	1.200	1.333	2.667
	.016	.031	.047	.062	.078	.093	.109	.124	.140	.156	.311	.467	.622	.778	.933	1.089	1.244	1.400	1.556	3.111
90	.015	.030	.045	.060	.075	.090	.105	.120	.135	.150	.300	.450	.600	.750	.900	1.050	1.200	1.350	1.500	3.000
	.017	.035	.052	.070	.087	.105	.122	.140	.157	.175	.350	.525	.700	.875	1.050	1.225	1.400	1.575	1.750	3.500
100	.017	.033	.050	.067	.083	.100	.117	.133	.150	.167	.333	.500	.667	.833	1.000	1.167	1.333	1.500	1.667	3.333
	.019	.039	.058	.078	.097	.117	.136	.156	.175	.194	.389	.583	.778	.972	1.167	1.361	1.556	1.750	1.944	3.889
200	.033	.067	.100	.133	.167	.200	.233	.267	.300	.333	.667	1.000	1.333	1.667	2.000	2.333	2.667	3.000	3.333	6.644
	.039	.078	.117	.156	.194	.233	.272	.311	.350	.389	.778	1.167	1.556	1.944	2.333	2.722	3.111	3.500	3.889	7.777
300	.050	.100	.150	.200	.250	.300	.350	.400	.450	.500	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500	5.000	10.000
	.058	.117	.175	.233	.292	.350	.408	.467	.525	.583	1.167	1.750	2.333	2.917	3.500	4.083	4.667	5.250	5.833	11.666
400	.067	.133	.200	.267	.333	.400	.467	.533	.600	.667	1.333	2.000	2.667	3.333	4.000	4.667	5.333	6.000	6.667	13.333
	.078	.156	.233	.311	.389	.467	.544	.622	.700	.778	1.556	2.333	3.111	3.889	4.667	5.444	6.222	7.000	7.777	15.555
500	.083	.167	.250	.333	.417	.500	.583	.667	.750	.833	1.667	2.500	3.353	4.167	5.000	5.833	6.667	7.500	8.333	16.667
	.097	.194	.292	.389	.486	.583	.686	.778	.875	.972	1.944	2.917	3.889	4.861	5.833	6.805	7.778	8.750	9.722	19.494

EXPLANATION.—To find from the above table the Interest of a given amount for a given number of days, refer to the square opposite the number of dollars at the left, and the number of days at the top. For $5000 remove the decimal point one place to the right.

* NOTES.—1 On account of space the table is condensed as much as possible; but in practice any interest table may be used, so that the interest on any amount for any number of days may be seen at a glance, and thus calculations may be greatly facilitated. This table is calculated at 360 days per year.

2. Accounts may be averaged by any per cent., but the cash balance can only be found by using the legal rate per cent.

TABLE OF SIMPLE INTEREST, AT SEVEN PER CENT.,

For each Day to a Month, from $1 to $100.

Amount	DAYS IN THE MONTH.																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
4	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
5	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3
6	0	0	0	0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4
7	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4
8	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5
9	0	0	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	5	5	5	5	5
10	0	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	5	5	5	5	6	6	6
20	0	1	1	2	2	2	3	3	3	4	4	5	5	5	6	6	7	7	7	8	8	8	9	9	10	10	10	11	11	12	12
30	1	1	2	2	3	3	4	5	5	6	6	7	7	8	9	9	10	10	11	12	12	13	13	14	14	15	16	16	17	17	18
40	1	2	2	3	4	5	5	6	7	8	8	9	10	11	12	12	13	14	15	15	16	17	18	18	19	20	21	21	22	23	24
50	1	2	3	4	5	6	7	8	9	10	11	12	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
60	1	2	3	5	6	7	8	9	10	12	13	14	15	16	17	18	20	21	22	23	24	25	26	28	29	30	31	32	33	35	36
70	1	3	4	5	7	8	9	11	12	13	15	16	17	19	20	21	23	24	26	27	28	29	31	32	34	35	36	38	39	40	42
80	2	3	5	6	8	9	11	12	14	15	17	18	20	21	23	25	26	28	29	31	32	34	35	37	38	4	41	43	44	46	48
90	2	3	5	7	9	11	12	14	16	17	19	21	22	24	26	28	29	31	33	35	36	38	40	41	43	45	47	48	50	52	54
100	2	4	6	8	10	12	13	15	17	19	21	23	25	27	29	30	33	35	36	38	40	42	44	46	48	50	2	54	56	58	59

EXPLANATION.—Find the amount in the left hand column then follow the line of figures until you come to the column giving the number of days at the head and you have the amount of days to one month; then by adding together, you have the interest of as many months as required, on amounts from one dollar to one hundred.

TABLE OF SIMPLE INTEREST, AT SIX PER CENT.,

For each Day to a Month, from **$1** *to* **$100.**

Amount.	DAYS IN THE MONTH.																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2
4	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
5	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3
6	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
7	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4
8	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4
9	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	5	6
10	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5
20	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10
30	1	1	1	1	2	2	3	4	4	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	15
40	1	1	2	2	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	13	14	15	15	16	17	17	18	19	19	20	20
50	1	2	3	3	4	5	6	7	8	8	9	10	11	12	13	13	14	15	16	17	17	18	19	20	21	22	23	23	24	25	26
60	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
70	1	2	3	5	6	7	8	9	10	12	13	14	15	16	17	19	20	21	22	23	24	26	27	28	29	30	31	33	34	35	36
80	1	3	4	5	7	8	9	11	12	13	15	16	17	19	20	21	23	24	25	27	28	29	31	32	33	35	36	37	39	40	41
90	2	3	5	6	7	9	11	12	13	15	16	18	19	21	22	24	25	27	28	30	31	33	35	36	38	39	41	42	44	45	47
100	2	3	5	7	8	10	12	13	15	17	18	20	22	23	25	27	28	30	32	33	35	37	38	40	42	43	45	47	48	50	51

EXPLANATION.—Find the amount in the left hand column then follow the line of figures until you come to the column giving the number of days at the head and you have the amount of days to one month; then by adding together, you have the interest of as many months as required on amounts from one dollar to one hundred.

TABLE OF WAGES AT $3.00 to $25.00 PER MONTH OF 26 WORKING DAYS,

For any number of days from 1 to 26.

Days	$3.	$4.	$5.	$6.	$7.	$8.	$9.	$10.	$11.	$12.	$13.	$14.	$15.	$16.	$17.
1	.12	.15	.19	.23	.27	.31	.35	.38	.42	.46	.50	.54	.58	.62	.66
2	.23	.31	.39	.46	.54	.62	.69	.77	.85	.92	1.00	1.08	1.15	1.23	1.31
3	.35	.46	.57	.69	.81	.92	1.04	1.15	1.27	1.38	1.50	1.62	1.73	1.85	1.96
4	.46	.62	.77	.93	1.07	1.23	1.38	1.54	1.69	1.85	2.00	2.15	2.31	2.46	2.62
5	.58	.77	.96	1.15	1.34	1.54	1.73	1.92	2.12	2.31	2.50	2.69	2.88	3.08	3.27
6	.69	.83	1.15	1.38	1.62	1.85	2.08	2.31	2.54	2.77	3.00	3.23	3.46	3.69	3.92
7	.81	1.07	1.31	1.62	1.88	2.15	2.42	2.69	2.96	3.23	3.50	3.77	4.04	4.31	4.58
8	.92	1.23	1.54	1.84	2.15	2.46	2.77	3.08	3.38	3.69	4.00	4.31	4.62	4.92	5.23
9	1.04	1.38	1.73	2.07	2.42	2.77	3.12	3.46	3.81	4.15	4.50	4.85	5.19	5.54	5.88
10	1.15	1.54	1.92	2.31	2.69	3.08	3.46	3.85	4.23	4.62	5.00	5.38	5.77	6.15	6.54
11	1.27	1.69	2.12	2.54	2.96	3.38	3.81	4.23	4.65	5.08	5.50	5.92	6.35	6.77	7.19
12	1.38	1.84	2.31	2.77	3.23	3.69	4.15	4.62	5.08	5.54	6.00	6.46	6.92	7.38	7.85
13	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50
14	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.38	5.92	6.46	7.00	7.54	8.08	8.62	9.15
15	1.73	2.31	2.88	3.46	4.04	4.62	5.19	5.77	6.35	6.92	7.50	8.08	9.05	9.23	9.81
16	1.85	2.46	3.08	3.69	4.31	4.92	5.54	6.16	6.77	7.38	8.00	8.62	9.23	9.85	10.46
17	1.96	2.61	3.27	3.92	4.58	5.23	5.88	6.54	7.19	7.85	8.50	9.15	9.81	10.46	11.12
18	2.08	2.77	3.46	4.15	4.84	5.51	6.23	6.92	7.62	8.31	9.00	9.69	10.38	11.08	11.77
19	2.19	2.93	3.62	4.38	5.11	5.85	6.58	7.31	8.04	8.77	9.50	10.23	10.96	11.69	12.42
20	2.31	3.07	3.84	4.61	5.38	6.15	6.92	7.69	8.46	9.23	10.00	10.77	11.54	12.31	13.08
21	2.42	3.23	4.04	4.84	5.65	6.46	7.27	8.08	8.88	9.69	10.50	11.31	12.12	12.92	13.73
22	2.54	3.38	4.23	5.07	5.92	6.77	7.61	8.46	9.31	0.15	11.00	11.85	12.69	13.54	14.38
23	2.65	3.54	4.42	5.31	6.19	7.08	7.96	8.85	9.73	10.62	11.50	12.38	13.27	14.15	15.04
24	2.77	3.69	4.61	5.54	6.46	7.38	8.31	9.23	10.15	11.08	12.00	12.92	13.85	4.77	15.69
25	2.89	3.84	4.81	5.77	6.73	7.69	8.65	9.62	10.58	11.54	12.50	13.46	14.42	15.38	16.35
26	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00

Table continued.

Days	$18.	$19.	$20.	$21.	$22.	$23	$24.	$25.
1	.69	.73	.77	.81	.84	.88	.92	.96
2	1.38	1.46	1.54	1.62	1.70	1.77	1.84	1.92
3	2.08	2.19	2.31	2.42	2.54	2.65	2.74	2.88
4	2.77	2.92	3.08	3.23	3.38	3.54	3.70	3.85
5	3.46	3.65	3.85	4.04	4.24	4.42	4.62	4.81
6	4.15	4.38	4.62	4.85	5.08	5.31	5.54	5.77
7	4.85	5.12	5.38	5.65	5.92	6.19	6.46	6.73
8	5.54	5.85	6.16	6.46	6.76	7.08	7.38	7.69
9	6.23	6.58	6.92	7.27	7.62	7.96	8.31	8.65
10	6.92	7.31	7.69	8.08	8.46	8.85	9.24	9.62
11	7.62	8.04	8.46	8.88	9.30	9.73	10.16	10.58
12	8.31	8.77	9.23	9.69	10.16	10.62	11.08	11.54
13	9.00	9.50	10.00	10.50	11.00	11.50	12.00	12.50
14	9.69	10.23	10.77	11.31	11.84	12.38	12.92	13.46
15	10.38	10.96	11.54	12.12	12.70	13.27	13.84	14.42
16	11.08	11.69	12.31	12.92	13.54	14.15	14.74	15.38
17	11.77	12.42	13.08	13.73	14.38	15.04	15.70	16.35
18	12.46	13.15	13.85	14.54	15.24	15.92	16.62	17.31
19	13.15	13.88	14.62	15.35	16.08	16.81	17.54	18.27
20	13.85	14.62	15.38	16.15	16.92	17.69	18.46	19.23
21	14.54	15.35	16.16	16.96	17.76	18.58	19.38	20.19
22	15.23	16.08	16.92	17.77	18.62	19.46	20.30	21.15
23	15.92	16.81	17.69	18.58	19.43	20.35	21.24	22.11
24	16.62	17.54	18.46	19.38	20.30	21.23	22.16	23.08
25	17.31	18.27	19.23	20.19	21.16	22.12	23.08	24.04
26	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00

EXPLANATION.—The column on the left hand of the table shows the number of days: and the rate per month is seen at the top of the page.

EXAMPLE.—To find the amount of 19 days' work, at $11 per month: find 19 in the column of days; then move to the right, on the same line, till you come under $11 (rate per month), and you find $8.04—the answer.

In all cases, the amount will be found directly under the price per month, and at the right of the given time.

In this table, the wages are cast at 26 working days per month. For a fraction of a day, take an equal part of the amount for one day, and for rates less than $3 per month, half what is shown for twice the amount.

Should it be desired to ascertain the wages per day for any given sum per month above $25, it can be done by adding to or doubling the above amounts. Thus for $30 per month, take 20 and 10 in the above table and add them; for $37 per month, take 20 and 10 and 7, and add them; for $50, take 25 and double it; for $75 per month, take 25 and triple it, &c.

KEEPING ACCOUNTS.

Blank account books, designed for keeping simple ledger accounts, are generally of two kinds, viz.: Those in which the *Dr.* and *Cr.* sides of the account are on the same page, and those in which they are on opposite pages. We give below samples of each, with the mode of keeping the account.

Page 72 WILLIAM WILSON. *Dr.* *Cr.*

			Dr.	*Cr.*
1861.				
Jan.	12	To 18 bus. potatoes, at 50 cts.	$9 00	$
"	20	" 1 ton hay, at $8	8 00	
"	25	By cash on account		10 00
Feb.	7	To 1 yoke steers sold you this day	80 00	
"	15	By 2000 feet pine boards, at $10. m.		20 00
"	20	To 30 bus. oats, at 30 cts	9 00	
Mar.	5	" 40 " corn, at 50 cts	20 00	
April	3	By 1 pair boots for Sam		4 00
"	10	" 50 lbs sugar at 8 cts		4 00
May	12	" 10 " coffee at 15 cts		1 50
June	7	To 3 cords wood at $2 50	7 50	
"	20	By cash on account		50 00
July	1	By balance of account charged below		44 00
			133 50	133 50
July	1	To balance of account	44 00	

Page 72.

WM. WILSON.			*Dr.*
1861.			
Jan.	12	To 18 bus. potatoes at 50 cts....	$9 00
"	20	To 1 ton hay at $8	8 00
Feb.	7	To 1 yoke steers sold you this day....	80 00
"	20	To 30 bus oats, at 30 cts	9 00
Mar.	5	To 40 bus. corn, at 50 cts....... ...	20 00
June	7	To 3 cords wood, at $2 50..........	7 50
			83 5
July	1	To balance of act...	44 00

Page 73.

WM WILSON.			*Cr.*
1861.			
Jan.	25	By cash on account.	$10 00
Feb'y	15	By 2000 feet pine boards. at $10 M	20 00
April	3	By 1 pair boots for Sam	4 00
"	10	By 50 lbs. sugar, at 8 cts............	4 00
May	12	By 10 lbs. coffee, at 15 cts...........	1 50
June	20	By cash on account.	50 00
July	1	By balance of acct charged.........	44 00
			133 50

Form of a Bill of the foregoing.

WILLIAM WILSON, *Dr.*

1861.		IN ACCOUNT WITH THOMAS BUNN, *Cr.*		
January	12,	To 18 bus. potatoes, at 50 cts........		$9 00
"	20,	" 1 ton hay, at $8..................		8 00
February	7,	" 1 yoke steers		80 00
"	20,	" 30 bus. oats, at 30 cts............		9 00
March	5,	" 40 bus. corn, at 50 cts............		20 00
June	7,	" 3 cords wood, at $2 50...........		7 50
1861		*Cr.*		$133 50
January	25,	By cash on account........	$10 00	
Feb'y	15,	" 2000 ft. lumber, at $10 M	20 00	
April	3,	" 1 pair boots for Sam....	4 00	
"	10,	" 50 lbs. sugar, at 8 cts....	4 00	
May	12,	" 10 lbs. coffee, at 15 cts..	1 50	
June	20,	" cash on account........	50 00	89 50
July	1,	To balance....................		$44 00

NOTE.—Since the whole science of book-keeping rests upon *charges* and *credits*, if you, once for all, get what is a charge and what is a credit clearly fixed in your mind, and fully understand when you ought to charge and when you ought to credit, you will have little difficulty in keeping your accounts straight, simple, and satisfactory.

When you let your neighbor, or he with whom you deal, have anything from you, it is a *charge* against him, and you must charge him with it on the debit side of the account; but whenever you receive anything from him, it is a *credit*, and you must credit him with it on the credit side of the account. Thus you "charge" for what you give, and "credit" for what you receive. He with whom you deal does likewise—charging you with what he gives you, and crediting you with what he receives from you. Hence his charges against you will correspond with your credits to him, and his credits to you will correspond with your charges against him.

In like manner, should it be desired to keep an account with a certain field, or meadow, or cow, the name is entered at the top of the page and in the index, just as an individual's, and what you give to it, the labor it costs you, &c., you charge to it, and what it yields you you credit to it. In this way a farmer can keep an account with each of his fields or altogether, with each of his cows or with the herd, with each of his pigs or altogether, with each of his sheep or with the whole flock, &c.

The word "*To*" prefixed to an entry indicates a charge or debit; the word "*By*" indicates a credit.

Each entry should be made on the day the transaction took place.

The account should be cast and balanced at least once every six months, and if not settled the balance brought down, as above, when the account may be continued.

BOOK-KEEPING BY DOUBLE ENTRY.

Book-keeping by *double entry* is that form of keeping accounts in which two entries are made in the Ledger for every one in the Day-Book; one a charge, or *debit*, and the other a *credit*. Thus you not only charge the party who *receives* from you, but you credit that department of your business from which, whatever it is, is received. You keep an account with as many different departments of your business as you deem necessary. A farmer might keep an account with his herd, with wheat, rye, corn, grass, hay, and other crops, or different fields, separately or together, under the head of "Farm." Where the time required can be spared, we think it desirable to keep accounts by double entry with every department of a business, down to a very minute detail, because where books are kept by this system, you can turn to any account and ascertain at a glance its condition; that is, how much money you have spent on it, and how much it has returned you, and what balance is for or against it. The books necessary to be used in keeping accounts by this system are two, the Day-Book and Ledger. A third, called a Journal, is sometimes used intermediary between the Day-Book and Ledger; but we consider it much more trouble than benefit, and therefore think best entirely to dispense with it.

The Day-Book is ruled with two dollar and cent columns on the right hand side, and one column on the left hand side, in which the page of the Ledger is entered when the account is transferred to the Ledger.

The Ledger is generally ruled, as in the example given below; the name of the account is written across the top of the page, and if the transactions will probably be numerous other pages following may be reserved to continue the account upon when the first page is full.

It is customary with a person keeping books by this method to have an account with "Cash," with his family, and if he takes and gives notes, with "Bills Receivable," and "Bills Payable." We will give below a sample of transactions entered in the Day-Book and carried to the Ledger. If I sold, October 1st, to John Brown, twenty bushels of apples, at 75 cents per bushel, and was to deliver them to him for $1, and on October 5th, bought of him five barrels of flour, for family use, at $4 per barrel, which he was to deliver gratis, my entries in the Day-Book would be as follows, supposing I kept accounts with the departments mentioned :—

Page 1.

CENTERVILLE, OCT. 1st, 1861.

5	JOHN BROWN, *Dr.*				
	Sold him 20 bus. apples, at 75 cts per bus. $15 00				
	Cartage.................................. 1 00	16	00		
	Cr.				
6	ORCHARD,......................			15	00
7	TEAMING......................			1	00
	— Oct. 5 —				
10	FAMILY EXPENSE. *Dr*				
	Bought of John Brown 5 bbls flour, at $4 per bbl	20	00		
	Cr.				
5	JOHN BROWN............			20	00

The Ledger accounts of the above would be as follows :—

Page 5.

Dr. JOHN BROWN. *Cr.*

1861. October	1		1	16	00	1861 Oct.	5		1	20	00

Page 7.

Dr. TEAMING. *Cr.*

						1861 Oct	5		1	1	00

Page 6.

Dr. ORCHARD. *Cr.*

						1861. Oct.	1		1	15	00

Page 10.

Dr. FAMILY EXPENSE. *Cr.*

1861. Oct.	5		1	20	00						

In the Day-Book, in the right hand dollar and cent column, the credits are entered; in the left hand, the debits, as shown.

In the Ledger, the half of the page to the left of the centre is devoted to debits; to the right, to credits. The column to the left of the dollar and cent column in the Ledger is where the page of the Day-Book from which the entry is taken is noted.

The form which we have given above is, perhaps, the simplest in which books can be kept by double entry, consequently the best. No difficulty will be experienced in this system of keeping books, after one has already fixed in his mind what is a charge or debit, and what is a credit, as explained above. Some remarks may not, however, be unnecessary in this connection, to show *what* to credit and *what* to charge, under certain circumstances. If you give a man a note for the balance of his account, you debit his account and credit Bills Payable. When you pay the note, you debit Bills Payable and credit Cash. If you receive a note for balance of account, you credit the man's account and debit Bills Receivable. When the note is paid, you credit Bills Receivable and debit Cash. In the first entry in the above example, it may be well to say, you do not give credit to the man who drives the wagon, or to the wagon for its use. These are legitimate charges against Teaming. At the proper time you credit the man his wages, and charge or debit Teaming for it (or that portion of his time in which he has been engaged teaming), &c.

Some businesses require an Interest account to be kept; of course, from our previous remarks, any one who finds it necessary will see the proper way to keep it.

It is necessary, in connection with the Day-Book and Ledger, to keep a Cash-Book and Bill-Books, where a person does a credit business. The Cash-Book, to keep a record of the receipts and disbursements of cash, which should be balanced every night (if any cash has been spent or received during the day), and the money counted; the balance on hand and the balance shown by the book should correspond; if they do not, something has been omitted. If you have on hand more than the balance calls for, you have received money which has not been entered on the debit side of the account. If you have too little, you have spent money for which the account has not been credited.

The Bill-Books are to keep a record of notes received and notes paid out. The Bills Payable book records the following facts: The date of the note, the time it is to run, the date of falling due, to whom it was given, in whose favor it was made, and the amount it was made for. The Bills Receivable book records: Who made the note, in whose favor it was made, how long it has to run, when it is due, and the amount it is for. When notes are paid or received, these facts should, of course, be properly noted in the Day-Book.

When accounts are first opened it is best to take an inventory of property of all kinds on hand, charging each department with which you intend to keep an account with that portion which it requires, and crediting an account for the same which shall represent all your "Stock in Trade." This account is usually called "Stock." Then, at the time you wish to close up your accounts to ascertain your profits and losses, you take another inventory, and give your departmental accounts credit for what property they have on hand, charging the general stock account for the same; the balance of this account (*i. e.*, the difference between the footing of the debit and credit columns) then shows how much more or less property you have on hand than when you commenced business. If the credit side exceeds the debit, of course you have more property; and if the debit exceeds the credit, of course you have less than when you began. Then the balance of each departmental account (all proper charges having been entered, and its share of property on hand credited) will show how much it has made or lost. These balances are then usually carried to a general account, called "Profit and Loss;" those having a credit balance are charged that amount, and Profit and Loss is credited; and those having a debit balance are credited that amount, and Profit and Loss is charged for it. This being done with the Departmental accounts and the General Stock accounts, with the Cash accounts, and the Bills Payable and Bills Receivable accounts, and Profit and Loss having been also charged for bad debts—and the parties owing them having been credited therefor—the balance of that account shows the Profit and Loss of the business. Some parties do not credit the accounts of persons who owe bad debts, and charge Profit and Loss; but, after making up the Profit and Loss account, draw it off on a sheet of paper, and account for them there. Others open an account called "Suspense," to which they credit the amount of the several bad debts (specifying them in the Day-Book), and charge Profit and Loss. This method prevents the accounts of bad debtors appearing closed on your Ledger. After you have made up your books as directed, it is best to make a balance sheet, which will show at a glance what departments have made money, what lost, who owes you, and who you owe. After this, the several departments should be charged back again with the property with which they are to commence the next year's business, and the stock account credited therefor, and you are ready to begin again.

Trial balances of the Ledger should be made, say monthly. To make a trial balance, you foot up all the columns of figures in your Ledger, draw off the debits on one side of a sheet and add them together, and the credits on the other side of the sheet and add them together. If the footings of the debit and credit columns thus obtained are the same, or, in other words, balance, your Ledger balances and is all right; but if they do not balance but differ, your Ledger is in error, and you must go over it and find where the mistake is.

Of course there must be no entry made in your Ledger, unless it is also made in your Day-Book. The wording of the Day-Book must be as simple as possible and express all the facts.

Some book-keepers, when they enter from the Day-Book into the Ledger, write in the Ledger between the date column and the column of the Day-Book page the name of the account in the Ledger which receives the corresponding entry or entries; thus, in the entry above given they would write thus:—

Page 5.

Dr. JOHN BROWN. *Cr.*

1861.						1861.					
Oct.	1	To Orchard, . .	1	15	00	Oct.	5	By Family Expenses	1	20	00
"		" Teaming, .	1	1	00						

This we think of no advantage, and it increases the labor and trouble. When you render a bill from the account, you must necessarily turn to the Day-Book to ascertain the particulars, and the mere page of the Day-Book is sufficient for this purpose. The less accounts are complicated the easier they are kept, and the less liable are mistakes to be made.

No erasures, scratching out, or interlineations should be suffered. If a wrong entry be made, or an entry made wrongly, let it be explained by a counter entry on the other side of the account, or overscored in such a manner that the mistake can be seen. All erasures, blotting out, scratching, &c., tend to throw suspicion upon the honesty of the account.

Books of "Original Entries" are only an aid of the memory, and he who keeps them should be able to swear that the entries were made on the day they purport to have been. He may not be able to recollect the various entries, but if it was his invariable custom to make them on the day of the transaction, they stand in place of his memory—they are not, however, evidence of the *delivery* of the goods.

Form of a Receipt in full.

NEW YORK, July 1st, 1861.

Received of Thomas Brown the sum of forty-four dollars, in full of all accounts up to this date.

$44 00. WILLIAM WILSON.

Form of a Check.

$150 00. New York, July 1st, 1861.

Please pay William Wilson, or order, one hundred and fifty dollars, and charge to the account of

Thomas Anderson.

To the Southold Savings Bank.

Form of a Due-Bill.

New York, July 1st, 1861.

Due William Wilson, or order, on settlement this day, one hundred and fifty dollars.

$150 00. Thomas Anderson.

Form of a Promissory Note.

New York, July 1st, 1861.

Four months after date I promise to pay William Wilson, or order, one hundred and fifty dollars; value received.

$150 00. Thomas Anderson.

Another form.

New York, July 1st, 1861.

On the 1st day of April next, I promise to pay William Wilson, or order, one hundred and fifty dollars; value received.

$150 00. Thomas Anderson.

Form of a Promissory Note with Surety.

New York, July 1st, 1861.

Sixty days after date, we, or either of us, promise to pay William Wilson, or order, one hundred and fifty dollars; value received. Thomas Anderson, (Principal.)

$150 00. John Jones, (Surety.)

Form of a Draft or Bill of Exchange.

$150 00. BUFFALO, July 1st, 1861.

Ten days after sight, pay William Wilson, or order, one hundred and fifty dollars, value received, and charge the same to account of

Yours, &c., THOMAS ANDERSON.

To William Allen, New York.

NOTES.—A due-bill bears interest from its date; a promissory note not until after it is due, unless so expressed on its face.

NEGOTIABILITY.—The words, "or order," "or bearer," are necessary to make a check, a due-bill, a promissory note, a bill of exchange, &c., *negotiable;* that is, to enable the holder of it to trade and pass it to another.

When the words "or bearer" are introduced, the instrument may then pass from hand to hand, like a bank-bill, without endorsement; but when the words "*or order*" are used, the instrument must be endorsed by the original holder of it.

ENDORSEMENT.—Endorsing a note is writing your name across the back of it. Endorsements are of two kinds, an endorsement in blank or general endorsement, and a special endorsement.

An *endorsement in blank* is the original holder's simply writing his name across the back of it. The succeeding holders of it may or may not, also, endorse it. If each or any of them do, they also become severally bound for its payment.

A *special endorsement* is made by writing across the back of it, before endorsing it, the words, "Pay to the order of [name of party to whom it is passed]," which *limits* the payment of it to that party, or *his* orders, and so forth.

ACCEPTANCE.—When a draft or bill of exchange is made upon a third party (as in the above form), the latter is not in any way bound by it until he accepts it, which he does when it is presented to him for acceptance, by writing across the face of it the word "*accepted*," with the date, and signing his name thereunder. He is then a party to the bill, and bound for its payment at maturity.

PROTEST.—Protest is the notice required by law to be given to the endorsers of promissory notes, and the makers and endorsers of bills of exchange, of their dishonor, that is, of their non-acceptance or non-payment.

If the drawee, or person to whom a bill of exchange is directed, refuses to accept it on presentation, notice must be immediately given to the maker of it.

If he accepts it, and afterwards fails to pay it at maturity, notice must immediately be given to the maker.

If the maker of a promissory note fails to pay it at maturity, notice must immediately be given to all the endorsers.

A check is a draft at sight, and if not paid, must be protested.

It is a general rule that all *guarantors* of commercial paper must be immediately notified of its dishonor.

It is, of course, not necessary to protest a due-bill, or a promissory note, which is still held by the person to whom it was originally given.

When a note is made payable "*on demand*," it is necessary to make a demand before it will bear interest or can be sued for.

U. S. BONDS.

Interest is calculated on U. S. bonds and on the public debt at 365 days to the year, and is due semi-annually. In England interest is calculated in the same way, and the legal rate is 5 per cent.

By Five-Twenties is meant the 6 per cent. gold-bearing bonds of the United States, which are to mature in 20 years, but which the Government, by giving due notice, can pay in gold any time after five years from the date of issue.

The old five-twenties were the first issued. They bear date May 1, 1862, and are redeemable after May 1, 1867, and payable May 1, 1882. The new "five-twenties" were issued Nov. 1, 1864, July 1, 1865, and Nov. 1, 1865.

By Ten-Forties is meant the 5 per cent. gold-bearing bonds which are to mature in 40 years, but which may be paid by the Government at any time after 10 years.

By Seven-Thirties is meant a *currency* loan, which matures in 3 years, at which time they may be changed for the *five-twenty* 7 per cent. bonds, bearing interest in gold. The name is derived from the rate of interest, it being 7.3 per cent. The "First series" bear date Aug. 15, 1864. The "Second series" bear date June 15, 1865, and are convertible June 15, 1868. The "Third series" bear date July 5, 1865. On this issue the Government reserves the right to pay the interest at 6 per cent. in gold, instead of 7.30 per cent. in currency.

By Six per cents. of '81 is meant the 6 per cent. gold-bearing bonds which cannot be redeemed by Government, except by purchase, until after maturity.

RELATIVE VALUE OF GOLD AND CURRENCY.

To ascertain the value in gold of a "greenback" dollar or National currency, at the different quotations of gold:

RULE.—Divide $1 by the quoted value of $1 in gold; the result will be *the value* of a dollar in currency.

EXAMPLE.—When gold is 33 per cent. premium what is the value of $1 in currency? $1.00÷$1.33=.7522.

NOTE.—In the following table the decimals are carried to mills and tenths of a mill.

TABLE, *showing the greenback value of* $1 *at the different quotations of gold. When gold is at*

.01 pr. ct. prem. a greenback dollar is worth.	.99	.12 pr. ct. prem. a greenback dollar is worth..	.8929
.02	.9803	.13	.885
.03	.9708	.14	.8771
.04	.9615	.15	.8695
.05	.9523	.16	.862
.06	.9433	.17	.8564
.07	.9355	.18	.8474
.08	.9259	.19	.8403
.09	.9174	.20	.8333
.10	.909	.21	.8264
.11	.9009	.22	.8279

.23 pr. ct. prem. a greenback dollar is worth.	.813	.37 pr. ct. prem. a greenback dollar is worth..	.7308
.24	.8064	.38	.7246
.25	.80	.39	.7194
.26	.7928	.40	.7142
.27	.7874	.41	.7092
.28	.7812	.42	.7042
.29	.7751	.43	.6993
.30	.7692	.44	.6944
.31	.7633	.45	.6896
.32	.7575	.46	.6849
.33	.7522	.47	.2162
.34	.7462	.48	.6758
.35	.7409	.49	.6716
.36	.7353	.50	.6666

NOTE.—The highest quotation of gold at the New York Stock Exchange during the war was 285, July 11th, 1864. A dollar currency was then worth 35 cents. Gold in Richmond, Va., reached 4400, Feb. 4th, 1865. A dollar in Confederate currency was worth .02¼ cents.

ENGLISH BONDS AND CONSOLS.

Exchequer Bills are English bonds, similar to those of the U. S. The rates of interest vary from 5 to 3 per cent., and while the Government pays the interest, it cannot be required to refund the principal.

Consols are several English securities consolidated by act of Parliament. The rate of interest is 3 per cent.

The Stock Exchange is an association for the purpose of buying and selling stocks.

A Broker is a person who executes orders for those who are not members of the exchange.

A Jobber deals in stock on his own account. A "stag," or "outsider," is a broker who is not a member of the exchange.

A Bull is one who buys stock to be delivered to him at a future time, with the intention of selling it, in the meantime, at a higher price before he is obliged to receive it.

A Bear is one who sells stock that he does not own, to be delivered at a future date, hoping in the meantime to buy it at a less price. A "lame duck" is one who is unable to fulfil his contracts, and hence is expelled from the exchange.

"Selling Short" is applied to sales of stock which the seller does not own, deliverable at a future time, generally not exceeding 60 days. The *bears* usually "sell short." The buyer pays interest for over 3 days.

"Seller's Option" gives the seller the privilege of delivering the stock at any time before the time specified for delivery.

"Buyer's Option" gives the purchaser the privilege of claiming the delivery of the stock at any time before the time specified for delivery.

STOCK QUOTATIONS.

From N. Y. Herald.

Sales.			
12000	Am. G	143½	$12000 gold at 43⅛ per cent. premium.
12000	U. S. 6's. '81 cou	112⅝	$12000 U. S. 6 per cent. coupon bonds, maturing 1881, at 12⅝ per cent. premium.
10000	U. S. 5–20 Reg. '62	104½	U. S. 5–20 Registered Bonds isued in 1862.

40000 Tr'y. N. 7-30 2d s.	107	Treasury notes at 7.3 per cent. interest, second series.
100 N. Y. Cen. 7's, '65-'76	120	100 Shares of New York Central RR. 7 per cent. bonds issued in 1865, and maturing in 1876.
500 Hud. R. 7's 1st M	101	Hudson R. 7 per cent. first mortgage bonds.
200 " " 2d M. S. F.	104	Hudson R. 7 per cent. second mortgage sinking fund.
100 E. RR. 2 d's	51⅜	Erie RR. sold at 2 days' credit at 51⅜ cents per dollar.
100 " b. 5 w. n.	51	Erie RR. to be delivered before 5 days without notice.
1000 C. and Am. 6's, '89	108½	Camden and Amboy 6 per cent. maturing in 1889.
100 Mich. C. 6's, b. 15 and int.	107¾	Mich. Cent. RR. Stock to be delivered before 15 days with interest.
100 U. S. Tr. 7-30 int. F. & A.	111⅛	U. S. Treasury notes 7.3 per cent. interest paid in February and August.
1000 Erie pref. s., w. n.	88	Erie Preferred Stock without notice.
100 Penn. 6's, int. off.	104	Pennsylvania 6 per cent. stock, the last interest of which has been paid.
500 E. RR. b. o.	23	Erie RR. stock, "Buyer's Option," when to call for the stock.
300 " s. o.	31	Erie RR. stock, "Seller's Option," when to deliver the stock.

SUCCESS IN BUSINESS.

Short Credits.

Short credit has much to do with the amount of profits in business. The difference between long and short credits will be seen by the following table, showing the amount of $100 in ten years.

	Am't at 3 pr. ct.	Am't at 5 pr. ct.	Am't at 8 pr. ct.	Am't at 10 pr. ct.
If turned over every 3 months,	$326.20	$703.99	$2172.45	$4525.92
" " " 6 "	180.61	265.32	466.09	672.75
" " " 8 "	155.79	207.89	317.21	417.72
" " " 12 "	134.39	162.88	215.89	259.37
" " " 2 years,	115.92	127.62	146.93	161.05
" " " 5 "	106.09	110.25	116.64	121.00

Small Profits.

By the above table it will be seen that quick sales and small profits are more desirable than large profits and long credits. It must be considered, however, before reducing profits, whether the sales can be increased so as to compensate for the reduction of profits.

Economy in Expense.

Many a young man in business fails to succeed, owing to a want of economy in expense. *All expense must be deducted from the profits.* "Fortunes are spent by trifles." "A penny saved is worth two earned."

2	cents per day	in ten years	will amount to	$100.85	at 7 p. c.	compound int.
5	"	"	"	252.14	"	"
25	"	"	"	1260.71	"	"
50	"	"	"	2521.42	"	"
100	"	"	"	5042.84	"	"
$2	"	"	"	10085.68	"	"

Marking Goods.

It is customary among merchants to use a private mark to denote the cost and selling price of goods. Any word or phrase containing ten different letters is selected, and used to represent figures, as "White sugar," "Misfortune," &c., thus:

w	*h*	*i*	*t*	*e*	*s*	*u*	*g*	*a*	*r*
1	2	3	4	5	6	7	8	9	0

An extra letter called a "repeater" is generally used to prevent the repetition of a figure, as *x*, *y*, or *z*, &c.; thus 388 would be represented by *igz*, using *z* as a repeater, instead of *igg*. The object is to prevent a clue being given to the key-word. Any mark or character may be used to represent a figure instead of a letter. Fractions may be written thus, $473\frac{2}{3} = tui\frac{h}{i}$; or by an arbitrary mark, thus, ○ may represent $\frac{2}{3}$, then $473\frac{2}{3} = tui$ ○. Sometimes the cost mark is written below a line, and the selling price above; thus,

$$\frac{4.62}{3.24} = \frac{tsh \text{ sell. pr.}}{iht \text{ cost.}}$$

THE OTIS PATENT LIGHTNING ROD,

AS APPLIED TO THE N. Y. STATE ARSENAL.

M. WELLS, Electrician, 112 Broadway, N. Y.

LIGHTNING-RODS.

The humid gases, generated by the heating and sweating of the hay, which immediately follows its accumulation in closely-packed masses, offers a strong attraction to electricity, just at the time when it is most abundant. It is an object of peculiar importance to the farmer to guard his buildings, at such times, with properly constructed lightning-rods; and they are a cheap mode of insurance against fire from this cause, as the expense is trifling and the security great.

As an example of the more elaborate style of rods, we show in the accompanying cut the manner in which Otis' Patent Lightning-Rods have been applied to the New York State Arsenal.

To construct a lightning-rod.

Take round or square soft iron $\frac{3}{4}$ of an inch in diameter, in pieces of convenient length; connect the pieces by splitting one end and flattening and inserting the other, and fasten with a rivet or screw, so that the rod preserves its uniform thickness throughout. Or, the pieces may be connected in a more perfect manner, although not often so convenient, by having a male screw cut on one end of the pieces and a female screw on the other, and simply screwing them together as the rod is raised; care being taken that the pieces are brought in contact at the outer edge, so as to form a united surface. If a square rod is used, notch the corners with a single downward stroke of a cold chisel, at intervals of two or three inches. No part of the rod should be painted, as its efficiency would be greatly impaired. Let the upper extremity consist of one finely drawn point of copper or silver, or well gilded iron, to prevent rusting. Let the lower part of the rod, at the surface of the ground, terminate in two or three flattened divergent branches, leading several feet outwardly from the building, and buried at a depth which reaches perpetual moisture, in a bed of charcoal. Attach the rod to the building by clasps protruding three or four inches and containing glass rings or funnels for the rod to pass through. The rod must not touch the building nor the iron clasps, but only the glass; because, the latter being a non-conductor of electricity, in the event of the rods being struck by lightning, the charge is conducted harmlessly to the ground, having no point of contact with a conductor by which it might be led into the building. Upon reaching the top of the building the rod should be conducted to the centre of the ridge, and the end should then be raised to a height equal to one-half of the distance to the end of the ridge. If the roof is irregular in height, of course judgment must be used in fixing the point where the end of the rod rises above the roof, bearing in mind this important consideration—that the rod protects objects at twice the distance of its height above any point in a line perpendicular to its upper termination.

The conducting power of bodies is in the ratio of their surfaces. Hence a bundle of wires, ribbons, or tubes of metal, are more efficient than an equal quantity of solid, round, or square rods.

The *conductors* of electricity in the order of their power are, copper, silver, gold, iron, tin, lead, zinc, platinum, charcoal, black lead, strong acids, soot and lampblack, metallic ores, metallic oxides, dilute acids, saline solutions, animal fluids, sea-water, fresh water, ice, living vegetables, living animals, flame, smoke, vapor and humid gases, salts, rarified air, dry earth and massive minerals.

The *non-conductors* in their order are, shellac, amber, resins, sulphur, wax, asphaltum, glass, all vitrified bodies, raw silk, bleached silk, dyed silk, wool, hair, feathers, dry paper, parchment and leather, baked wood and dry vegetables.

The question of the utility of lightning-rods is not clearly decided; and certainly very grave doubts exist as to the usefulness of the various complicated patent devices which are hawked about the country, under the sanction of splendid testimonials.

Dr. Franklin's theory was,—and he claimed to have proved it by having drawn the electricity harmlessly from a cloud over his kite-string,—that the value of the lightning-rod consists, not in its ability to receive shocks, but in the fact that it taps the surcharged clouds and conveys the electricity quietly to the earth.

Based upon this theory, there has recently been advanced an idea that seems sensible. It is to substitute a piece of galvanized telegraph wire for the kite-string, a pointed rod of iron at the top of the building for the kite, and another rod driven into the ground for the key in Dr. Franklin's hand.

The iron at the top should project five or six feet above the roof, and if the ridge-pole is more than twenty feet long, there should be two or more of these, all to be connected with each other and with the rod in the ground by simple wire.

This plan has the great merit of being cheap and within the reach of all—and, so far as anything is actually known of the subject, is as good as the more elaborate and expensive ones.

PRESSURE OF EARTH AGAINST WALLS.

To find the pressure of the different kinds of earths, filling, &c., against walls, it is necessary first to ascertain the line or angle of rupture, or *natural slope*, the earth would assume but for the resistance of the wall. This natural slope differs with the different kinds of earths. Assuming that the earth is level with the top of the wall, the line of rupture for the different kinds of earths, filling, &c., will be as follows:—

A bank of *vegetable earth* will rupture on the surface at a distance from the top of the wall of three-fifths the height of the wall.

A bank of *sand* will rupture at two-thirds the height of the wall.

A bank of *unhewn stone*, at one-seventh the height of the wall.

A bank of *rubble* at two-fifths the height of the wall.

A bank of *brick*, with a bank of vegetable earth behind it, will rupture at a distance of about one-sixth the height of the wall.

A bank of *clay*, well rammed, will rupture at a distance of three-sixteenths the height of the wall.

The strongest horizontal stress against the wall is at half the angle which the natural slope makes with it; hence:

The greatest pressure for a bank of *vegetable earth* will be at three-tenths the height of the wall from the bottom.

For a bank of *sand*, at one-third the height of the wall.

For a bank of *rubble*, at one-fifth the height of the wall.

For a bank of *unhewn stone*, at one-fourteenth the height of the wall.

For a bank of *brick*, at one-twelfth the height of the wall.

For a bank of *clay*, at three-thirty-seconds the height of the wall.

Walls should therefore be built proportionably strong to these heights to sustain the different pressures. If the bank is liable to be saturated with water the wall should be doubled in strength.

FRACTIONS—DECIMALS.

A fraction is one or more parts of a unit, and is expressed by fractional characters, thus, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{3}{4}$; or by decimals, thus, .5, .25, .75.

When expressed by fractional characters, the upper figure is called the *numerator*, because it numbers or gives value to the fraction, by showing how many parts of the whole number into which the unit is divided is taken; and the lower figure is called the *denominator*, because it names the number of parts into which the unit is divided. Thus, $\frac{3}{8}$ means that the unit is divided into 8 parts, and that 3 out of the 8 are taken, &c.

When expressed by a decimal, the decimal number shows that so many parts of the unit are taken, the unit itself being impliedly divided into as many parts as will correspond with the decimal number, and still retain its ratio to it. Thus, .5 means $\frac{5}{10}$, .25 means $\frac{25}{100}$, .125 means $\frac{125}{1000}$, &c.

To reduce fractions to decimals.

Divide the numerator by the denominator, adding cyphers as required.

EXAMPLE.—What are the decimals of $\frac{1}{2}$, $\frac{3}{4}$, and $\frac{\ }{8}$?

SOLUTION.—$10 \div 2 = .5$, $300 \div 4 = .75$, $7000 \div 8 = .875$. *Ans.*

To add decimals.

Add as in common addition, setting the whole numbers or integers directly under each other from the decimal point to the left, and the decimals from the decimal point to the right, as in the following example:—

12.75
24.027
14.5
16.1278

67.4048

To subtract decimals.

Set the whole numbers and decimals under each other, as directed above, and proceed as in common subtraction, as in the following example:—

75.15
28.875

46.275

To multiply decimals.

Set the figures and multiply as in common multiplication, and point off in the product as many decimals as there are decimal places in the multiplier and multiplicand, as in the following example:—

23.25
22.15

11625
2325
4650
4650

514.9875

To divide decimals.

Proceed as in common division, and point off to the right in the quotient as many decimals as the decimal places in the dividend exceed the decimal places in the divisor, as in the following example:—

```
2.48] 129.952 [52.4
      124 0
      -----
        5 95
        4 96
        ----
```

Useful decimals.

1/16	.0625	1/3	.333+	1/9	.1111+
1/8 (2/16)	.125	2/3	.666+	2/9	.2222+
3/16	.1875	1/5	.2	1/3 (3/9)	.3333+
1/4 (4/16)	.25	2/5	.4	4/9	.4444+
5/16	.3125	3/5	.6	5/9	.5555+
3/8 (6/16)	.375	4/5	.8	2/3 (6/9)	.6666+
7/16	.4375	1/7	.1428+	7/9	.7777+
1/2 (8/16)	.5	2/7	.2856+	8/9	.8888+
9/16	.5625	3/7	.4285+	1/10	.1
5/8 (10/16)	.625	4/7	.5712+	2/10 (1/5)	.2
11/16	.6875	5/7	.7141+	3/10	.3
3/4 (12/16)	.75	6/7	.8569+	4/10 (2/5)	.4
13/16	.8125			7/10	.7
7/8 (14/16)	.875			9/10	.9
15/16	.9375				

FACTS ABOUT PRINTING AND BOOK-MAKING.

The following are the different styles of type ordinarily used in book-printing:—

PICA.

Springs are weakened by use, but recover their strength if laid by.

SMALL PICA.

Metals have five degrees of lustre—splendent, shining, glistening, glimmering, and dull.

LONG PRIMER.

The hardness of metals is as follows: Iron, Platinum, Copper, Silver, Gold, Tin, Lead.

BOURGEOIS.

A fall of 1-10 of an inch a mile will produce a current in rivers.

BREVIER.

Melted snow produces about 1-8 of its bulk of water.

MINION.

Silica is the basis of the mineral world, and carbon of the organized.

NONPAREIL.

Sound passes in water at a velocity of 4708 feet per second, and in air 1100 feet, at a temperature of 33°.

AGATE.

At the depth of 45 feet, the temperature of the earth is uniform throughout the year.

PEARL.

The weight of a cubic foot of air is 527.04 grains, or 1 205 ounces, avoirdupois.

NOTE.—*Diamond* is smaller than pearl—*Emerald* still smaller.

We do not apologize for giving the above and the few following facts about printing, because that art has become so universally used by all classes that it is of practical importance to disseminate information in regard to it.

The specimens given above are called Roman; CAPITALS and SMALL CAPITALS belong legitimately with this style. *Italics* are cast to accompany it, to give emphasis to certain parts of the matter being composed, or set up. Italic figures and small capitals of italic are not made. Many other styles of type, such as Black Letter, Script, Church Text, Clarendon, Title, Ionic, Full Face, &c., are cast, and are ordinarily used to display certain lines in Job Printing, and are consequently called job type.

Printers generally charge for the setting of type, or, as they technically term it, the composition of matter, by the number of *ems* it contains. An *em* is the square of the body of the type; they measure the matter composed by multiplying the number of ems or lines it is in length by the number of ems or lines it is in width. Nonpareil is half the size in body of Pica, consequently 4 ems of Nonpareil equal 1 of Pica. Agate is half Small Pica. Pearl is half Long Primer.

In 1 square inch there are			....	36	ems	Pica.
"	"	"	....	50	"	Small Pica.
"	"	"	....	$56\frac{1}{4}$	"	Long Primer.
"	"	"	....	$72\frac{1}{4}$	"	Bourgeois.
"	"	"	....	87	"	Brevier.
"	"	"	....	$113\frac{3}{4}$	"	Minion.

In 1 square inch there are	144	ems	Nonpareil.
" " "	200½	"	Agate.
" " "	225	"	Pearl.

That is according to the type in the office where this book is printed; different founders vary the sizes of type slightly, so that the above is not a perfectly accurate guide in measuring the number of ems in a page or book; still it is sufficiently so to give a very close approximation to what any printer would measure. In using the above to calculate in ems the contents of a page or book, be particular to calculate *square inches*, not *inches square.* The price of type-setting in New York varies with the different printers. Generally the price for book composition is from 80c. to $1.00 per 1000 ems. Much figure-work is charged extra, so also is an extra charge made where a very narrow column is set. Pearl is charged extra on account of its smallness. The price given is for plain matter.

Presswork is charged for by the *token*, which is 250 impressions of the press. Prices vary so much per token, according to the quality of the work and the number of impressions, that it is next to impossible to give an idea of it that will benefit the reader. Plain book-work, in editions of 1000 to 2000 copies, is charged usually at 50c. to $1.00 per token.

SIZES OF BOOKS.

The various sizes of books were named from the number of folds that were made of a sheet of paper 19 inches by 24, which, at the time the sizes of books acquired their names, was the largest sheet manufactured. Thus, a sheet of that size folded once, making 2 leaves or 4 pages, was called a folio volume; folded twice, making 4 leaves or 8 pages, was called a quarto volume; folded four times, making 8 leaves or 16 pages, was called an octavo; folded six times, making 12 leaves or 24 pages, was called a duodecimo, &c. They are written thus: 2fo., 4to, 8vo, 16mo, &c.

Afterwards, when the sheets came to be manufactured larger, books continued to be designated as above, but were distinguished from the above sizes by giving the new sheets names, and prefixing the name of the sheet to the above. Thus, a sheet 22 inches by 28 was called "Royal," and hence books printed on it were called royal folio, royal quarto, royal octavo, &c.

TABLE, *showing the number of leaves and pages from the folding of a sheet.*

		Folds.	Leaves.	Pages.
Sheet of 19 inches by 24.	2fo	1	2	4
	4to	2	4	8
	8vo	4	8	16
	12mo	6	12	24
	16mo	8	16	32
	18mo	9	18	36
	24mo	12	24	48
	32mo	16	32	64

NOTE.—The foldings, leaves, and pages of the royal sheet, &c., are the same as the above, but the sheet being larger of course the leaves and pages are larger.

STRENGTH OF MATERIALS.

Tensile strength.

Tensile strength is the amount of cohesion existing between the atoms of a mass, or the tenacity with which the fibres or particles of a body resist separation. The tensile strength of a body is therefore in proportion to the number of its fibres, or to the area of its section.

TABLE, *showing the weight in lbs. necessary to tear asunder one square inch of the following substances.*

METALS.		WOODS	
Designation.	Wt. in lbs.	Designation.	Wt. in lbs.
Copper, wrought......	34,000	Ash	16,000
" cast..........	19,000	Beach	11,500
" wire	61,200	Birch	15,000
Gold, cast............	20,000	Box	20,000
Iron, "	27,000	Cedar................	11,400
Iron Wire	103,000	Chesnut	10,500
" best bar	72,000	Cypress	6,000
" medium bar......	60,000	Elm	13,400
" inferior "	30,000	Fir, strongest.........	12,000
Lead................	880	" American	8,800
Platinum wire	53,000	Lig. vitæ	11,800
Silver, cast...........	40,000	Locust	20,500
Steel	120,000	Mahogany	21,000
Tin, block	5,000	Maple	10,500
Zinc, cast	3,500	Oak, American, white..	11,500
Brass	42,000	" seasoned.......	13,600
		Pine, Pitch..........	12,000
		Poplar	7,000
		Sycamore	13,000
		Walnut	7,000
		Willow	13,000

To find the tensile strength.

RULE.—Multiply the area of the transverse section in inches, by the weight given in the preceding table, and the product will be the strength in lbs.

EXAMPLE.—What is the tensile strength of a seasoned white oak scantling 2 inches by 3?

SOLUTION.—$2\times3=6$, area of transverse section, $\times13{,}600$ $=81{,}600$ lbs. *Ans.*

EXAMPLE SECOND.—What is the tensile strength of a round poplar stick 3 inches in diameter?

SOLUTION.—7.068, area of circle (*vide* table of the areas of circles), $\times7{,}000=49{,}476$ lbs. *Ans.*

EXAMPLE THIRD.—What is the tensile strength of the best bar iron, 2 inches broad by 1 inch thick?

SOLUTION.—$2\times1=2$, area of transverse section, $\times72{,}000$ $=144{,}000$ lbs. *Ans.*

NOTE.—The above gives the *maximum tensile strength* of the materials, or the *utmost strain* they are capable of sustaining when drawn lengthwise. But it is to be borne in mind that the *practical value* is about *one-fourth* of the above.

TABLE, *showing the strength of iron wire rope and hempen cable.*

	Circumference of Wire Rope in inches.	Trade Number.	Circumference of Hemp Rope, of equal strength, in inches.	Breaking weight in tons of 2,000 lbs.
Fine Wire,..	6.02	1	15½	74.
	6.20	2	14½	65.
	5.44	3	13	54.
	4.90	4	12	43.6
	4.50	5	10¾	35.
	3.91	6	9½	27.2
	3.86	7	8	20.2
	2.98	8	7	16.
	2.56	9	6	11.4
	2.45	10	5	8.64
Coarse Wire,	4.45	11	10¾	36.
	4.00	12	10	30.
	3.63	13	9½	25.
	3.26	14	8¼	20.
	2.98	15	7¼	16.
	2.68	16	6¼	12.3
	2.40	17	5½	8.8
	2.12	18	5	7.6
	1.9	19	4.75	5.8
	1.63	20	4.	4.09
	1.53	21	3.3	2.83
	1.31	22	2.80	2.13
	1.23	23	2.46	1.65
	1.11	24	2.2	1.38
	0.94	25	2.04	1.03
	0.88	26	1.75	0.81
	0.78	27	1.50	0.56

J. A. Roebling, C. E.

STRENGTH OF CABLES, ROPES, AND HAWSERS.

To find the strength of cables.

RULE.—Multiply the square of the circumference in inches by 120, and the product is the weight in lbs. the cable will bear with safety.

EXAMPLE.—What weight will a cable 6 inches in circumference bear with safety?

SOLUTION.—$6^2=36\times120=4320$ lbs. *Ans.*

To find the strength of ropes and hawsers.

RULE.—Multiply the square of the circumference in inches by 200, and it gives the weight in lbs. the rope will bear with safety.

TABLE, *showing what weight a hemp rope will bear with safety.*

Circumference.	lbs	Circumference.	lbs.	Circumference.	lbs.
1	200	3½	2450.	6	7200.
1¼	312.5	3¾	2812.5	6¼	7812.5
1½	450.	4	3200.	6½	8450.
1¾	612.5	4¼	3612.5	6¾	9112.5
2	800.	4½	4050.	7	9800.
2¼	1012.5	4¾	4512.5	7¼	10512.5
2½	1250.	5	5000.	7½	11250.
2¾	1512.5	5¼	5512.5	7¾	12012.5
3	1800.	5½	6050.	8	12800.
3¼	2112.5	5¾	6612.5		

STRENGTH OF METAL AND WOODEN RODS.

A rod having an area of the 1000th part of a square inch, made of the following materials, will sustain weights as follows:—

Designation.	Lbs.	Designation.	Lbs.
Cast steel	134	Tin	5
Best wrought iron	70	Lead	2
Cast iron	19	Oak	12
Copper	19	Beach	12½
Platinum	16	Ash	14
Silver	11	White Pine	11
Gold	9		

HEMPEN CORDS.

Hempen cords when twisted will support the following weights to the *square inch* of their section:—

Diameter.	Lbs.	Diameter.	Lbs.
¼ to 1 inch..........	8746	3 to 5 inches.........	5345
1 to 3 inches.........	6800	5 to 7 inches.........	4860

NOTE.—A square inch of hemp fibres will support a weight of 9200 lbs.

The *maximum* strength of a good hemp rope is 6400 lbs. to the square inch. Its *practical* value not more than one-half this strain. Before breaking it stretches from ⅕ to ⅐, and its diameter diminishes from ¼ to ⅐.

The strength of manilla is about ½ that of hemp. White ropes are ⅓ more durable.

LATERAL OR TRANSVERSE STRENGTH.

TABLE, *showing the transverse strength of timber*, 1 *foot long and* 1 *inch square: Weight suspended from one end.*

Materials.	Breaking weight. Lbs.	Greatest deflection. Inches.	Weig't borne with safety. Lbs.	Value for gener'l use. Lbs.
White oak, seasoned	240.	9.	196.	40.
Chesnut, "	170.	1.8	115.	65.
Yellow pine, "	150.	1.7	100.	62.
White " "	135.	1.4	95.	64.
Ash, "	175.	2.4	105.	77.
Hickory, "	270.	8.	200.	50.

TABLE, *showing the transverse strength of iron—square bar, 2 inches by 12 inches long: Weight suspended from one end.*

Material.	Breaking weight, Lbs.	Weight borne safely Lbs.	Value.	Value for general use.
Cast iron	5781	4000	400	290

Round, 3 inches diameter by 12 inches long: Weight suspended from end.

Material.	Breaking weight, Lbs.	Weight borne with safety. Lbs.	Value.	Value for general use
Cast iron.	12000	8000	240	175

NOTE.—The strength of a projecting beam is only *one-fourth* of what it would be if supported at both ends, and only *one-sixth* of what it would be if *fixed* at both ends. The former is to the latter as 2 is to 3.

To find the transverse strength when the bar or beam is fixed at one end and the load applied at the other.

RULE.—Multiply the value in the preceding table by the breadth, and square of the depth in inches, and divide the product by the length in feet. The quotient will be the weight in lbs.

EXAMPLE.—What weight will a seasoned white oak beam 4 inches square and projecting 36 inches sustain?

SOLUTION.—$4 \times 4^2 \times 40 = 2560 \div 3$ feet, projection, $= 853\frac{1}{3}$ lbs. *Ans.*

EXAMPLE 2d.—What weight will a cast iron bar 2 inches square and projecting 4 feet sustain?

SOLUTION.—$2 \times 2^2 \times 400 = 3200 \div 4 = 800$ lbs. *Ans.*

NOTE.—When the beam is loaded uniformly throughout its length the result must be doubled.

When the bar or beam is fixed at both ends and the weight applied in the middle.

RULE.—Multiply the value in the preceding table by six times the breadth, and the square of the depth in inches, and divide the product by the length in feet.

EXAMPLE.—What weight will an ash beam 8 inches deep by 10 broad and 10 feet long sustain in the middle, when fixed at the ends?

SOLUTION.—$77 \times 60 \times 8^2 = 295680 \div 10 = 29568$ lbs. *Ans.*

EXAMPLE 2d.—What weight will a cast iron bar 2 inches square and 4 feet long support, when applied in the middle, the ends being fixed?

SOLUTION.—400×12, six times breadth, $\times 2^2 = 19200 \div 4 = 4800$ lbs. *Ans.*

NOTE.—When the weight is equally distributed along its entire length, the above results must be doubled.

When the bar or beam is supported at both ends and the weight applied in the middle.

RULE.—Multiply the value in the preceding table by the square of the depth, and four times the breadth in inches, and divide the product by the length in feet.

EXAMPLE.—What weight will a white pine beam 8 inches broad by 6 deep and 6 feet long carry when applied in the middle, the ends being supported?

SOLUTION.—$64 \times 6^2 \times 32 = 24576 \div 6 = 4129 +$ lbs. *Ans.*

EXAMPLE 2d.—What weight will a cast iron bar 2 inches square and 60 inches between the supports carry?

SOLUTION.—$400 \times 2^2 \times 8 = 12800 \div 5$ feet $= 2560$ lbs. *Ans.*

TABLE, *showing the resistance of materials to crushing.*

Designation.	Crushing weight per square inch.	
	In lbs.	In tons of 2000 lbs.
WOODS.		
Ash	8,683	4.3
Beech, well seasoned,	19,363	9.6
Birch, " "	11,663	5.8
Cedar,	5,863	2.9
Elder,	9,973	4.9
Elm, well seasoned,	10,331	5.1
Fir, (spruce,)	6,819	3.4
Mahogany,	8,198	4.09
Oak,	5,982	2.9
Pine, pitch,	6,790	3.3
" yellow,	5,445	2.7
Poplar,	5,124	2.5
Sycamore, highly seasoned,	12,101	6.
Walnut,	7,227	3.6
Willow,	6,128	3.06
METALS.		
Brass, yellow,	10,304	5.15
Iron, cast,	98,000	49.
" bar	40,000	20.
" boiler plate,	32,000	16.
MINERALS.		
Brick, common,	800	0.40
" fire,	1,700	0.85
Brickwork,	612	0.306
Chalk	334	0.16
Granite	11,000	5.50

STRENGTH OF ICE.

Ice 2 inches thick will bear men on foot.
" 4 " " " " horseback.

Ice 6	inches	thick	will bear	cattle and teams with light loads.
" 8	"	"	"	teams with heavy loads.
" 10	"	"	will sustain a pressure of 1000 lbs. per square foot.	

This supposes the ice to be sound throughout its whole thickness, without "snow-ice."

WEIGHT OF SQUARE ROLLED IRON.

From $\frac{1}{16}$ inch to 12 inches, and 1 foot in length.

Size in inches.	Weight in pounds.	Size in inches.	Weight in pounds.	Size in inches.	Weight in pounds.	Size in inches.	Weight in pounds.
.$\frac{1}{16}$	.013	2.	13.520	4.$\frac{3}{8}$	64.700	7.$\frac{1}{2}$	190.136
		2.$\frac{1}{8}$	15.263	4.$\frac{1}{2}$	68.448	7.$\frac{3}{4}$	203.024
.$\frac{1}{8}$	.053	2.$\frac{1}{4}$	17.112	4.$\frac{5}{8}$	72.305	8.	216.336
.$\frac{3}{16}$	.118	2.$\frac{3}{8}$	19.066	4.$\frac{3}{4}$	76.264	8.$\frac{1}{4}$	230.068
		2.$\frac{1}{2}$	21.120	4.$\frac{7}{8}$	80.333	8.$\frac{1}{2}$	244.220
.$\frac{1}{4}$	.211	2.$\frac{5}{8}$	23.292	5.	84.480	8.$\frac{3}{4}$	258.800
.$\frac{3}{8}$	.475	2.$\frac{3}{4}$	25.560	5.$\frac{1}{8}$	88.784	9.	273.792
.$\frac{1}{2}$	.845	2.$\frac{7}{8}$	27.939	5.$\frac{1}{4}$	93.168	9.$\frac{1}{4}$	289.220
.$\frac{5}{8}$	1.320	3.	30.416	5.$\frac{3}{8}$	97.657	9.$\frac{1}{2}$	305.056
.$\frac{3}{4}$	1.901	3.$\frac{1}{8}$	33.010	5.$\frac{1}{2}$	102.240	9.$\frac{3}{4}$	321.332
.$\frac{7}{8}$	2.588	3.$\frac{1}{4}$	35.704	5.$\frac{5}{8}$	106.953	10.	337.920
1.	3.380	3.$\frac{3}{8}$	38.503	5.$\frac{3}{4}$	111.756	10.$\frac{1}{4}$	355.136
1.$\frac{1}{8}$	4.278	3.$\frac{1}{2}$	41.408	5.$\frac{7}{8}$	116.671	10.$\frac{1}{2}$	372.672
1.$\frac{1}{4}$	5.280	3.$\frac{5}{8}$	44.418	6.	121.664	10.$\frac{3}{4}$	390.628
1.$\frac{3}{8}$	6.390	3.$\frac{3}{4}$	47.534	6.$\frac{1}{4}$	132.040	11.	408.960
1.$\frac{1}{2}$	7.604	3.$\frac{7}{8}$	50.756	6.$\frac{1}{2}$	142.816	11.$\frac{1}{4}$	427.812
1.$\frac{5}{8}$	8.926	4.	54.084	6.$\frac{3}{4}$	154.012	11.$\frac{1}{2}$	447.024
1.$\frac{3}{4}$	10.352	4.$\frac{1}{8}$	57.517	7.	165.632	11.$\frac{3}{4}$	466.684
1.$\frac{7}{8}$	11.883	4.$\frac{1}{4}$	61.055	7.$\frac{1}{4}$	177.672	12.	486.656

EXAMPLE.—What is the weight of a bar of rolled iron $1\frac{1}{2}$ inches square and 12 inches long?

In column 1st find $1\frac{1}{2}$, and opposite to it is 7.604 pounds, which is 7 lbs. and $\frac{604}{1000}$ of a lb. If the lesser denomination of ounces is required, the result is obtained as follows: Multiply the remainder by 16, pointing off the decimals as in multiplication of decimals, and the figures remaining on the left of the point indicate the number of ounces.

$$\text{Thus, } \tfrac{604}{1000} \text{ of a lb.} = .604 \times 16 = 9.664 \text{ ounces.}$$

The weight, then, is 7 lbs. $9.\frac{664}{1000}$ ounces.

If the weight for less than a foot in length was required, the readiest operation is this:

EXAMPLE.—What is the weight of a bar $6\frac{1}{4}$ inches square and $9\frac{3}{4}$ inches long?

In column 5th, opposite to $6\frac{1}{4}$, is 132.040, which is the weight for a foot in length.

$6\frac{1}{4} \times 12$ inches			$=132.040$
6.	"	is $\frac{1}{2}$	$=$ 66.020
3.	"	is $\frac{1}{2}$ of $6=$	33.010
$.\frac{1}{2}$	"	is $\frac{1}{6}$ of $3=$	6.5016
$.\frac{1}{4}$	"	is $\frac{1}{2}$ of $\frac{1}{2}=$	2.7508
$9.\frac{3}{4}$			$=108.\frac{2824}{10000}$ pounds.

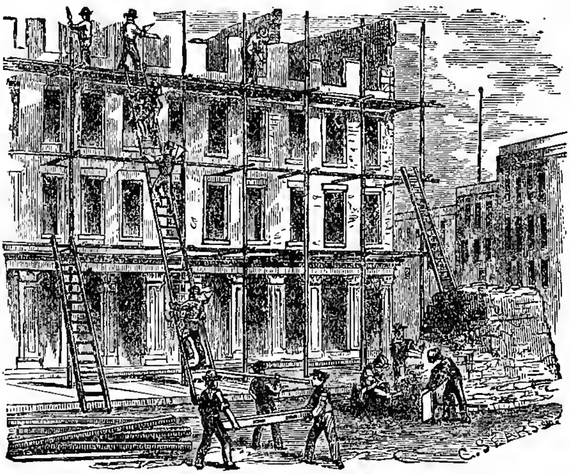
WEIGHT OF ROUND ROLLED IRON.

From ¼ inch to 12 inches diameter, and 1 foot in length.

Diamet'r in inches	Weight in pounds.	Diamet'r in inches	Weight in pounds.	Diamet'r in inches	Weight in pounds.	Diamet'r in inches	Weight in pounds.
.1/16	010	2.⅛	11.988	4.½	53.760	7.¾	159.456
		2.¼	13.440	4.⅝	56.788	8.	169.856
.⅛	.041	2.⅜	14.975	4.¾	59.900	8.¼	180.696
.3/16	.093	2.½	16.688	4.⅞	63.094	8.½	191.808
.¼	.165	2.⅝	18.293	5.	66.752	8.¾	203.260
.⅜	.373	2.¾	20.076	5.⅛	69.731	9.	215.040
.½	.663	2.⅞	21.944	5.¼	73.172	9.¼	227.152
.⅝	1.043	3.	23.888	5.⅜	76.700	9.½	239.600
.¾	1.493	3.⅛	25.926	5.½	80.304	9.¾	252.376
.⅞	2.032	3.¼	28.040	5.⅝	84.001	10.	266.288
1.	2.654	3.⅜	30.240	5.¾	87.776	10.¼	278.924
1.⅛	3.360	3.½	32.512	5.⅞	91.634	10.½	282.988
1.¼	4.172	3.⅝	34.886	6.	95.552	10.¾	306.800
1.⅜	5.019	3.¾	37.332	6.¼	103.704	11.	321.216
1.½	5.972	3.⅞	39.864	6.½	112.160	11.¼	336.004
1.⅝	7.010	4.	42.464	6.¾	120.960	11.½	351.104
1.¾	8.128	4.⅛	45.174	7.	130.048	11.¾	366.536
1.⅞	9.333	4.¼	47.952	7.¼	139.544	12.	382.208
2.	10.616	4.⅜	50.815	7.½	149.328		

The application of this table is precisely similar to that of the preceding one.

MASONRY.



A perch of stone is 24.75 cubic feet; when built in the wall, 22 cubic feet make 1 perch, $2\frac{3}{4}$ cubic feet being allowed for the mortar and filling.

Three pecks of lime and four bushels of sand to a perch of wall.

To find the number of perches of stone in walls.

RULE.—Multiply the length in feet by the height in feet, and that by the thickness in feet, and divide the product by 22, and the quotient will be the number of perches of stone in the wall.

Example.—How many perches of stone contained in a wall 40 feet long, 20 feet high, and 18 inches thick?

Solution.—40 feet, length, × 20 ft., height, × $1\frac{1}{2}$ feet, thick, $=1200\div22=54.54$ perches. *Ans.*

Note.—To find the number of perches of *masonry*, divide the product, as above, by 24.75, instead of 22.

Brick-work.

The dimensions of common bricks are from $7\frac{3}{4}$ to 8 inches long, by $4\frac{1}{4}$ wide, and $2\frac{1}{2}$ thick. Front bricks are $8\frac{1}{4}$ inches long, by $4\frac{1}{2}$ wide, and $2\frac{1}{2}$ thick.

The usual size of fire bricks is $9\frac{1}{8}$ inches long, by $4\frac{5}{8}$ wide, by $2\frac{3}{8}$ thick.

Twenty common bricks to a cubic foot when laid; 15 common bricks to a foot of 8-inch wall when laid.

To find the number of common bricks in a wall.

Rule.—Multiply the length of the wall in feet by the height in feet, and that by its thickness in feet, and that again by 20, and the product will be the number of bricks in the wall.

Example.—How many common bricks in a wall 40 feet long by 20 feet high and 12 inches thick?

Solution.—40 ft., length, × 20 ft., height, × 1 ft., thick. × $20=16000$. *Ans.*

Note.—For walls 8 ins. thick, multiply the length in feet by the height in feet, and that by 15, and the product will be the number of bricks in the wall.

When the wall is perforated by doors and windows, or other openings, find the sum of their cubic feet by severally multiplying their lengths and widths and thicknesses in feet together, and deducting the whole from the cubic contents of the wall, including the openings, before multiplying by 20 or 15, as above.

Laths.

Laths are 1¼ to 1½ inches wide by 4 feet long, are usually set ¼ inch apart, and a bundle contains 100.

THE MECHANICAL POWERS.

The mechanical powers are three in number, namely: the LEVER, the INCLINED PLANE, and the PULLEY. The wheel and the axle is a *revolving* lever; the wedge is a *double* inclined plane, and the screw is a *revolving* inclined plane.

THE LEVER.

To find the length of the longest arm of the lever; the weight to be raised, the power to be applied, and the length of the shortest arm of the lever being given.

RULE.—Multiply the weight by its distance from the fulcrum and divide the product by the power, and the quotient is the distance from the fulcrum the power must be applied, or, the longest arm of the lever.

EXAMPLE.—Given, a weight of 900 lbs., distant 2 feet from the fulcrum, to be raised by a force or power of 75 lbs.; required, the length of the longest arm of the lever.

SOLUTION.—900 lbs., the weight, $\times 2$ feet, distance from fulcrum, $=1800 \div 75$ lbs., the power, $=24$ feet. *Ans.*

To find the length of the shortest arm of the lever; the weight to be raised, the power to be applied, and the length of the longest arm of the lever being given.

RULE.—Multiply the power by its distance from the fulcrum, and divide the product by the weight, and the quotient is the distance the weight must be placed from the fulcrum, or, the shortest arm of the lever.

EXAMPLE.—What distance must a weight of 800 lbs. be placed from the fulcrum, to be raised by a power of 150 lbs. placed 8 feet from the fulcrum?

SOLUTION.—150 lbs., the power, ×96 inches, its distance from the fulcrum, =14400÷800 lbs., the weight, =18 inches. *Ans.*

To find the power required to raise a given weight; the distances of the weight and the power from the fulcrum being given.

RULE.—Multiply the weight by its distance from the fulcrum and divide the product by the distance of the power from the fulcrum.

EXAMPLE.—What power will raise a weight of 600 lbs. 20 inches from the fulcrum, applied 8 feet from the fulcrum?

SOLUTION.—600 lbs., weight, × 20 inches, distance of weight from fulcrum, =12000÷96 inches, distance of power from fulcrum, =125 lbs. *Ans.*

To find the weight, at a given distance from the fulcrum, a given power at a given distance from the fulcrum will raise.

RULE.—Multiply the power by its distance from the fulcrum and divide the product by the distance of the weight from the fulcrum.

Example.—What weight will a power of 250 lbs. 10 feet from the fulcrum raise, the weight placed 20 inches from the fulcrum?

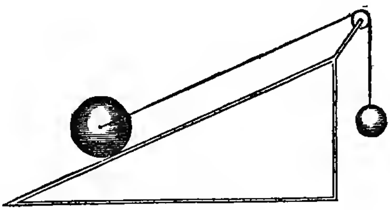
Solution.—250 lbs., the power, $\times$ 120 inches, its distance from the fulcrum, $=$ 30000 $\div$ 20 inches, distance of weight from fulcrum, $=$ 1500 lbs. *Ans.*

The general rule, therefore, for ascertaining the relation of power to weight in a lever, is: the power applied, multiplied by its distance from the fulcrum, is equal to the weight multiplied by its distance from the fulcrum.

The pressure upon the fulcrum equals the sum of the weight and power.

Note.—It must be remembered that, according to the foregoing rules and examples, the weight and force are made by the introduction of the lever to equal or balance each other. Hence, to get at their *practical value*, we must either shorten the short arm, or lengthen the long arm of the lever, add to the power, or deduct from the weight, to such an extent as each may judge for himself expedient under the circumstances.

THE INCLINED PLANE.



To find the power or force required to raise a given weight up an inclined plane of a given length and height.

RULE.—As the length of the plane is to its height, so is the weight to the power.

EXAMPLE.—Required the power necessary to raise 1500 lbs. up an inclined plane 20 feet long and 8 feet high?

SOLUTION.—As 20 : 8 :: 1500 : 600 lbs. *Ans.*

To find the height of an inclined plane when its length and base are given.

RULE.—Subtract the square of the base from the square of the length, and the square root of the remainder is the height.

EXAMPLE.—Given an inclined plane, the length of which is 40 feet and base 38: required, its height?

SOLUTION.—1600, square of length, — 1444, square of base, = $\sqrt{156} = 12.49$ feet. *Ans.*

To find the length when its base and height are given.

Rule.—Add the squares of the height and the base, and the square root of their sum will be the length.

Example.—What is the length of an inclined plane the base of which is 20 feet and its height 12?

Solution.—400, square of base, + 144, square of height, $= \sqrt{544} = 23.32$ feet. *Ans.*

To find the base when the length and height are given.

Rule.—Subtract the square of the height from the square of the length, and the square root of the remainder will be the base.

Example.—What is the base of an inclined plane, whose height is 10 feet, and length 25?

Solution.—625, square of length, — 100, square of height, $= \sqrt{525} = 22.91$ feet. *Ans.*

To find the pressure of a weight on an inclined plane when raised by its equivalent power.

Rule.—As the length is to the weight, so is the base to the pressure.

Example.—What is the pressure of 1000 lbs. on an inclined plane, the length of which is 80 feet and the base 70?

Solution.—80 feet, length, : 1000 lbs., :: 70 feet, base, : 875 lbs. *Ans.*

Notes.—When the line of direction of the power is parallel to the plane, the power is least and the pressure least.

When the power does not run parallel to the plane, draw a line perpendicular to the direction of the power's action from the end of the base line (at the back of the plane), and the intersection of this line on the length will determine the length and height of the base.

THE WHEEL AND THE AXLE.

The power multiplied by the radius of the wheel is equal to the weight multiplied by the radius of the axle.

As the radius of the wheel is to the radius of the axle, so is the effect to the power.

To find the weight a given tractile force or power will move on a wheel and axle of given radii.

Rule.—Multiply the tractile or drawing force by the radius of the wheel, and divide the product by the radius of the axle.

Example.—What weight will a tractile force of 250 lbs. draw on a wheel (or wheels) of a radius of 3 feet: radius of axle 4 inches?

Solution.—250 lbs., tractile force, × 36 inches, radius of wheel, = 9000 ÷ 4 inches, radius of axle, = 2250 lbs. *Ans.*

To find the tractile force required to move a given weight on a wheel and axle of given radii.

RULE.—Multiply the weight by the radius of the axle and divide the product by the radius of the wheel.

EXAMPLE.—Required, the tractile force necessary to draw 2000 lbs. on a wheel of $2\frac{1}{2}$ feet radius, and axle of 3 inches radius?

SOLUTION.—2000 lbs., weight, × 3 inches, radius of axle, = 6000÷30 inches, radius of wheel, = 200 lbs. *Ans.*

To find the radius required for a wheel to move a given weight by a given force on a given radius of axle.

RULE.—Multiply the weight by the radius of the axle and divide the product by the force.

EXAMPLE.—What radius must a wheel have, the radius of whose axle is 4 inches, to move a weight of 1320 lbs. by a force of 220 lbs?

SOLUTION.—1320 lbs., weight, × 4 inches, radius of axle, = 5280 ÷ 220 lbs., tractile force, = 24 inches. *Ans.*

To find the radius of an axle required to move a given weight by a given force, on a wheel of a given radius.

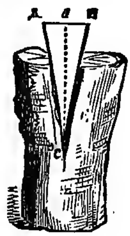
RULE.—Multiply the force by the radius of the wheel and divide the product by the weight.

EXAMPLE.—A weight of 1200 lbs. is to be moved on a wheel of 4 feet radius by a force of 150 lbs.: What must be the radius of the axle?

SOLUTION.—150 lbs., force, × 48 inches, radius of wheel, = 7200÷1200 lbs. = 6 inches. *Ans.*

NOTE.—It will be observed that, according to the above rules, illustrated by the foregoing examples, the power or force of traction and the weight or load are equivalents; that is to say, the one is, by the interposition of the wheel and axle, made to counterpoise the other. To find their easy *practical value*, deduct $\frac{1}{4}$ from the weight, or add $\frac{1}{6}$ to the tractile force.

THE WEDGE.



To find the force necessary to separate two bodies from one another in a direction parallel to the back of the wedge.

RULE.—As the length of the wedge is to half its back, so is the resistance to the force.

EXAMPLE.—The length of the back of a double wedge is 6 inches, and its length through the middle 12 inches. Required, the force necessary to separate a substance having a resistance of 200 lbs.?

SOLUTION.—12 inches, length, : 3 inches, back, :: 200 lbs., resistance, : 50 lbs. *Ans.*

To find the requisite force when only one of the bodies is movable.

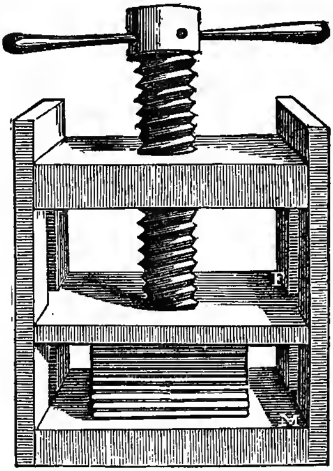
RULE.—As the length of the wedge is to its back, so is the resistance to the force.

EXAMPLE.—What power applied to the back of a wedge will raise a weight of 20,000 lbs.; the wedge being 6 inches deep and 100 long on its base?

SOLUTION.—100 inches, length, : 6 inches, depth, :: 20,000 lbs., weight, : 1200 lbs. *Ans.*

NOTE.—The power of the wedge increases as its length increases, or as the thickness of its back decreases.

THE SCREW.



The screw is a revolving inclined plane, or an inclined plane wound round a cylinder. Hence, when its length and its pitch, or height, are ascertained, the same rules that govern the inclined plane apply to the screw.

To find the length of the inclined plane of a screw.

RULE.—Add the square of the circumference of the screw to the square of the pitch, or distance between the threads, and take the square root of the same, which will be the length of the plane. The height is the distance between the consecutive threads.

EXAMPLE.—What is the length of the inclined plane of a screw of 12 inches circumference and 1 inch pitch?

SOLUTION.—$12^2+1^2=145$ and $\sqrt{145}=12.04159$ inches. *Ans.*

NOTE.—It will be observed that the length of the plane as given in the above example is the length of only *one turning of the screw*, or the length of once round the circumference, which, in ascertaining the power of a screw, is all that is necessary to be known of the length. The entire length of the plane and the entire height of the screw have nothing to do with its power. A single section, comprising one revolution of the plane or the cylinder, is enough.

To find the power required to raise a given weight by means of a screw of given dimensions.

RULE.—As the length of the inclined plane is to the pitch, or height of it, so is the weight to the power.

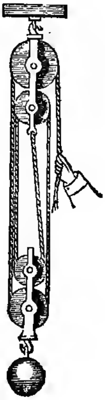
EXAMPLE.—What is the power requisite to raise 9000 lbs. by a screw 15 inches circumference, and $1\frac{1}{2}$ inches pitch?

SOLUTION.—$15^2+1\frac{1}{2}^2=227\frac{1}{4}$ and $\sqrt{227\frac{1}{4}}=15.62$ inches, length, then 15.62 inches, length, : $1\frac{1}{2}$ inches, pitch, : : 9000 lbs., weight, : 864.27 lbs. *Ans.*

NOTE.—When a wheel or capstan is applied to turn the screw, the length of the lever is the radius of the circle described by the handle of the wheel or capstan bar, and half the diameter of the screw is the radius of the axle.

When the screw is turned by a wheel, a crank, or capstan, find the power of the wheel, crank, or capstan by means of the rules given under "The Wheel and the Axle," and de duct the force thus acquired from the force necessary to drive the screw in raising the weight alone. The remainder is the force required to raise the weight by the combined power of the screw and the lever.

THE PULLEY.



When only one cord or rope is used.

To find the force necessary to raise a given weight by means of a pulley of a given number of sheaves, &c.

Rule.—Divide the weight to be raised by the number of parts of the rope engaged in supporting the lower or movable block.

EXAMPLE.—What is the force required to raise 600 lbs. by means of a lower block containing six sheaves: rope fastened to the upper block?

SOLUTION.—$2\times6=12$; then, $600\div12=50$ lbs. *Ans.*

EXAMPLE 2d.—What force when the rope is fastened to the lower block?

SOLUTION.—$6\times2+1=13$; then $600\div13=46.16$ lbs. *Ans.*

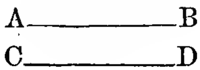
When more than one rope is used.

In a *Spanish Burton*, where there are two ropes, two movable pulleys, and one fixed and one stationary pulley, with the ends of one rope fastened to the support and upper movable pulley, and the ends of oe other fastened to the lower block and the power, the weight is to the power as 5 to 1.

In one where the ends of one rope are fastened to the support and the power, and the ends of the other to the lower and upper blocks, the weight is to the power as 4 to 1.

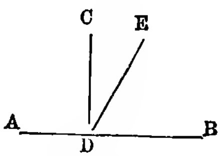
DEFINITIONS OF MATHEMATICAL FORMS.

FIG. 1.



Parallel Lines are everywhere equally distant; as, A B and C D.

FIG. 2.

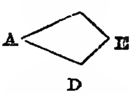


An *Angle* is the difference of direction between two lines which meet; as, A D E. The point of meeting is called the vertex of the angle, and when the angle is named the letter at the vertex is placed second; as, C D E.

FIG. 3.

A *Right Angle* is formed when a straight line meeting another makes two equal angles; as, A D C and C D B.

FIG. 4.



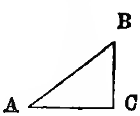
An *Acute Angle* is one less than a right angle; as, E B D, Fig. 3.

An *Obtuse Angle** is one greater than a right angle; as, A D E, Fig. 4.

A *Surface* has two dimensions—length and breadth.

A *Triangle* is a figure having three sides; as, A B C, Fig. 5.

FIG. 5.



The *Altitude* of a triangle is the perpendicular distance of the vertex from the line of the base; as, B C is the altitude of the triangle A B C, Fig. 5.

A *Right-Angle Triangle* is a triangle having a right angle;

* As the right anglo contains 90°, it follows that the acuto angle contains less, and the obtuse angle more, than 90°.

as, A C B, Fig. 5. The side opposite the right angle is called the hypothenuse; as, A B.

A *Parallelogram* is a four-sided figure whose opposite sides are parallel; as, Fig. 6.

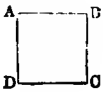
FIG. 6.

A *Rectangle* is a parallelogram whose angles are right angles; as, Fig. 7.

FIG. 7.

A *Square* is a rectangle the sides of which are equal. Fig. 8.

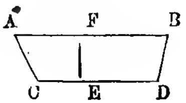
FIG. 8.



A *Trapezoid* is a four-sided figure having but two of its sides parallel; as, A B C D, Fig. 9.

The *Altitude* of a Parallelogram, a Rectangle, a Square or a Trapezoid is the perpendicular distance between the base and the line of the parallel side opposite the base; as, E F, Fig. 9.

FIG. 9.

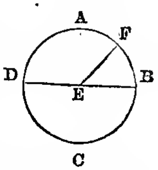


A *Circle* is a plane surface bounded by a line, every point of which is equally distant from a point called the centre; as, A B C D, Fig. 10.

The *Circumference* of a circle is the line by which it is bounded; as, A B C D, Fig. 10.

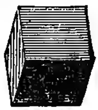
The *Diameter* of a circle is a straight line passing through the centre and terminating in the circumference; as, D E B, Fig. 10.

FIG. 10.



The *Radius* of a circle is the distance from the centre to the circumference; as, E F.

FIG. 11.



A *Solid* has three dimensions—length, breadth, and thickness; as, Fig. 11.

FIG. 12.

A *Prism* is a solid whose sides are parallelograms, and whose ends are equal and similar; as, Fig. 12.

When the ends of a prism are triangular, it is called a *triangular prism;* as, Fig. 12.

FIG. 13.

When the ends of a prism are square, it is called a *square prism;* as, Fig. 13.

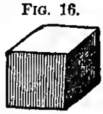
FIG. 14.

When the ends of a prism are hexagonal, it is called a *hexagonal prism;* as, Fig. 14.

FIG. 15.

When the ends of a prism are circular, it is called a *cylinder;** as, Fig. 15.

FIG. 16.



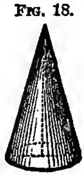
When all the sides of a rectangular prism are square, it is called a *cube;* as, Fig. 16.

FIG. 17.

A *Pyramid* is a solid, the base of which is a plane rectilinear figure, and having sides which are triangles whose vertices meet at a point at the top called the vertex of the pyramid. Fig. 17.

The *Altitude* of a pyramid or a cone is the perpendicular distance from the vertex to the plane of the base; as, Fig. 17.

FIG. 18.



A *Cone* is a solid, the base of which is a circle, and which tapers uniformly to a point at the top called a vertex. Fig. 18.

* A cylinder is a regular polygon, or prism, with an infinite number of sides.

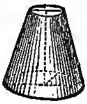
A *Frustum* of a pyramid or a cone is the part that remains after cutting off the top by a plane parallel to the base.

FIG. 19

Fig. 19 represents the frustum of a pyramid.

Fig. 20 represents the frustum of a cone.

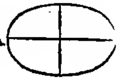
FIG. 20.



An *Ellipse* is a plane curve such that the sums of the distances of any points in the bounding line from two points within called the foci are always equal.

The line A B passing through the foci is called the major diameter; and the diameter perpendicular to A B at its centre is called the minor diameter.

FIG. 21.



A *Sphere* is a solid, bounded by a convex surface, every point of which is equally distant from a point within called the centre; as, Fig. 22.

FIG. 22.

A *Spheroid* is a solid, generated by the revolution of an ellipse about one of its diameters. If the ellipse revolves about its major diameter the spheroid is called *prolate*. If about its minor diameter the spheroid is called *oblate*.

FIG. 23.

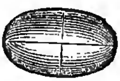


FIG. 24.

Fig. 23 represents a *prolate spheroid*.

Fig. 24 represents an *oblate spheroid*.

CIRCLES.

To find the circumference of a circle.

Rule 1.—Multiply the diameter by 3.1416, and the product will be the circumference.

Rule 2.—Or, as 7 is to 22 so is the diameter to the circumference.

Example.—What is the circumference of a circle whose diameter is 25?

Solution.—$25 \times 3.1416 = 78.54$. *Ans.* By Rule 2.—7 : 22 :: 25 : 78.5. *Ans.*

To find the diameter of a circle.

Rule 1.—Divide the circumference by 3.1416, and the quotient will be the diameter.

Rule 2.— Or, as 22 is to 7, so is the circumference to the diameter.

Example.—What is the diameter of a circle whose circumference is 69.11?

Solution.—$69.11 \div 3.1416 = 22$. *Ans.* By Rule 2.—22 : 7 :: 69.11 : 22. *Ans.*

To find the area of a circle.

Rule 1.—Multiply the square of the diameter by .7854, or the square of the circumference by .07958, and the product will be the area.

Rule 2.—Or, multiply half the circumference by half the diameter.

Rule 3.—Or, as 14 is to 11, so is the square of the diameter to the area.

Rule 4.—Or, as 88 is to 7, so is the square of the circumference to the area.

To find the side of an equal square containing the same area as a given circle.

Rule.—Take the square root of the area, which will be the side of the equal square.

To find the solidity of a sphere.

Rule.—Multiply the cube of the diameter by .5236, and the product is the solidity.

EXPLANATION AND USE OF THE FOLLOWING TABLE.

In the left hand column will be found the diameter of the circle; in the next column to the right will be found its corresponding circumference; in the third to the right will be found the area, and in the right hand column will be found the length of the side of an equal square containing the same area.

Example.—What is the side of a square having the same area as a circle of 64½ inches diameter?

Solution.—Find 64½ in the left-hand column, and opposite it to the right, under the heading "*Side of Equal Square,*" will be found 57.101, the length of the side. *Ans.*

TABLE, *showing the Areas of Circles and the Sides of their equivalent Squares, from* 1 *to* 100.

Diam.	Circum.	Area.	Side of equal square.	Diam.	Circum.	Area.	Side of equal square.
⅛	.3926	.01227	.110	11¾	36.91	108.43	10.413
¼	.7854	.04908	.221	12	37.69	113.09	10.634
½	1.570	.1963	.443	12¼	38.48	117.85	10.856
¾	2.356	.4417	.663	12½	39.27	122.71	11.077
1	3.141	.7854	.886	12¾	40.05	127.67	11.299
1¼	3.927	1.227	1.107	13	40.84	132.73	11.520
1½	4.712	1.767	1.329	13¼	41.62	137.88	11.742
1¾	5.497	2.404	1.550	13½	42.41	143.13	11.964
2	6.283	3.141	1.772	13¾	43.19	148.48	12.185
2¼	7.068	3.976	1.994	14	43.98	153.93	12.407
2½	7.854	4.908	2.215	14¼	44.76	159.48	12.628
2¾	8.639	5.939	2.437	14½	45.55	165.13	12.850
3	9.424	7.068	2.658	14¾	46.33	170.87	13.071
3¼	10.21	8.295	2.880	15	47.12	176.71	13.293
3½	10.99	9.621	3.101	15¼	47.90	182.65	13.514
3¾	11.78	11.044	3.323	15½	48.69	188.69	13.736
4	12.56	12.566	3.544	15¾	49.48	194.82	13.958
4¼	13.35	14.186	3.766	16	50.26	201.06	14.179
4½	14.13	15.904	3.988	16¼	51.05	207.39	14.401
4¾	14.92	17.720	4.209	16½	51.83	213.82	14.622
5	15.70	19.635	4.431	16¾	52.62	220.35	14.844
5¼	16.49	21.647	4.652	17	53.40	226.98	15.065
5½	17.27	23.758	4.874	17¼	54.19	233.70	15.287
5¾	18.06	25.967	5.095	17½	54.97	240.52	15.508
6	18.84	28.274	5.317	17¾	55.76	247.45	15.730
6¼	19.63	30.679	5.538	18	56.54	254.46	15.952
6½	20.42	33.183	5.760	18¼	57.33	261.58	16.173
6¾	21.20	35.784	5.982	18½	58.11	268.80	16.395
7	21.99	38.484	6.203	18¾	58.90	276.11	16.616
7¼	22.77	41.282	6.425	19	59.69	283.52	16.838
7½	23.56	44.178	6.646	19¼	60.47	291.03	17.059
7¾	24.34	47.173	6.868	19½	61.26	298.64	17.281
8	25.13	50.265	7.089	19¾	62.04	306.35	17.502
8¼	25.91	53.456	7.311	20	62.83	314.16	17.724
8½	26.70	56.745	7.532	20¼	63.61	322.06	17.946
8¾	27.48	60.131	7.754	20½	64.40	330.06	18.167
9	28.27	63.617	7.976	20¾	65.18	338.16	18.389
9¼	29.05	67.200	8.197	21	65.97	346.36	18.610
9½	29.84	70.882	8.419	21¼	66.75	354.65	18.832
9¾	30.63	74.662	8.640	21½	67.54	363.05	19.053
10	31.41	78.539	8.862	21¾	68.32	371.54	19.275
10¼	32.20	82.516	9.083	22	69.11	380.13	19.496
10½	32.98	86.590	9.305	22¼	69.90	388.82	19.718
10¾	33.77	90.762	9.526	22½	70.68	397.60	19.940
11	34.55	95.033	9.748	22¾	71.47	406.49	20.161
11¼	35.34	99.402	9.970	23	72.25	415.47	20.383
11½	36.12	103.86	10.191	23¼	73.04	424.55	20.604

Diam.	Circum.	Area.	Side of equal square.	Diam.	Circum.	Area.	Side of equal square
23½	73.82	433.73	20.826	36	113.	1017.8	31.904
23¾	74.61	443.01	21.047	36¼	113.8	1032.0	32.125
24	75.39	452.39	21.269	36½	114.6	1046.3	32.347
24¼	76.18	461.86	21.491	36¾	115.4	1060.7	32.568
24½	76.96	471.43	21.712	37	116.2	1075.2	32.790
24¾	77.75	481.10	21.934	37¼	117.	1089.7	33.011
25	78.54	490.87	22.155	37½	117.8	1104.4	33.233
25¼	79.32	500.74	22.377	37¾	118.6	1119.2	33.455
25½	80.10	510.70	22.598	38	119.3	1134.1	33.676
25¾	80.89	520.77	22.820	38¼	120.1	1149.0	33.898
26	81.68	530.93	23.041	38½	120.9	1164.1	34.119
26¼	82.46	541.18	23.263	38¾	121.7	1179.3	84.341
26½	83.25	551.54	23.485	39	122.5	1194.5	34.562
26¾	84.03	562.00	23.706	39¼	123.3	1209.9	34.784
27	84.82	572.55	23.928	39½	124.	1225.4	35.005
27¼	85.60	583.20	24.149	39¾	124.8	1240.9	35.227
27½	86.39	593.95	24.371	40	125.6	1256.6	35.449
27¾	87.17	604.80	24.592	40¼	126.4	1272.3	35.670
28	87.96	615.75	24.814	40½	127.2	1288.2	35.892
28¼	88.75	626.79	25.035	40¾	128.	1304.2	36.113
28½	89.53	637.94	25.257	41	128.8	1320.2	36.335
28¾	90.32	649.18	25.479	41¼	129.5	1336.4	36.556
29	91.10	660.52	25.700	41½	130.3	1352.6	36.778
29¼	91.89	671.95	25.922	41¾	131.1	1369.0	36.999
29½	92.67	683.49	26.144	42	131.9	1385.4	37.221
29¾	93.46	695.12	26.365	42¼	132.7	1401.9	37.443
30	94.24	706.86	26.586	42½	133.5	1418.6	37.664
30¼	95.03	718.69	26.808	42¾	134.3	1435.3	37.886
30½	95.81	730.61	27.029	43	135.	1452.2	38.107
30¾	96.60	742.64	27.251	43¼	135.8	1469.1	38.329
31	97.38	754.76	27.473	43½	136.6	1486.1	38.550
31¼	98.17	766.99	27.694	43¾	137.4	1503.3	38.772
31½	98.97	779.31	27.916	44	138.2	1520.5	38.993
31¾	99.74	791.73	28.137	44¼	139.	1537.8	39.215
32	100.0	804.24	28.359	44½	139.8	1555.2	39.437
32¼	101.3	816.86	28.580	44¾	140.5	1572.8	39.658
32½	102.1	829.57	28.802	45	141.3	1590.4	39.880
32¾	102.8	842.39	29.023	45¼	142.1	1608.1	40.101
33	103.6	855.30	29.245	45½	142.9	1625.9	40.323
33¼	104.4	868.30	29.467	45¾	143.7	1643.8	40.554
33½	105.2	881.41	29.688	46	144.5	1661.9	40.766
33¾	106.	894.61	29.910	46¼	145.2	1680.0	40.987
34	106.8	907.92	30.131	46½	146.	1698.2	41.209
34¼	107.5	921.32	30.353	46¾	146.8	1716.5	41.431
34½	108.3	934.82	30.574	47	147.6	1734.9	41.652
34¾	109.1	948.41	30.796	47¼	148.4	1753.4	41.874
35	109.9	962.11	31.017	47½	149.2	1772.0	42.095
35¼	110.7	975.90	31.239	47¾	150.	1790.7	42.317
35½	111.5	989.80	31.461	48	150.7	1809.5	42.538
35¾	112.3	1003.7	31.682	48¼	151.5	1828.4	42.760

Diam.	Circum.	Area.	Side of equal square.	Diam.	Circum.	Area.	Side of equal square.
48½	152.3	1847.4	42.982	61	191.6	2922.4	54.059
48¾	153.1	1866.5	43.203	61¼	192.4	2946.4	54.281
49	153.9	1885.7	43.425	61½	193.2	2970.5	54.502
49¼	154.7	1905.	43.646	61¾	193.9	2994.7	54.724
49½	155.5	1924.4	43.868	62	194.7	3019.0	54.946
49¾	156.2	1943.9	44.089	62¼	195.5	3043.4	55.167
50	157.	1963.5	44.311	62½	196.3	3067.9	55.389
50¼	157.8	1983.1	44.532	62¾	197.1	3092.5	55.610
50½	158.6	2002.9	44.754	63	197.9	3117.2	55.832
50¾	159.4	2022.8	44.976	63¼	198.7	3142.0	56.053
51	160.2	2042.8	45.197	63½	199.4	3166.9	56.275
51¼	161.	2062.9	45.419	63¾	200.2	3191.9	56.496
51½	161.7	2083.0	45.640	64	201.	3216.9	56.718
51¾	162.5	2103.3	45.862	64¼	201.8	3242.1	56.940
52	163.3	2123.7	46.083	64½	202.6	3267.4	57.161
52¼	164.1	2144.1	46.305	64¾	203.4	3292.8	57.383
52½	164.9	2164.7	46.526	65	204.2	3318.3	57.604
52¾	165.7	2185.4	46.748	65¼	204.9	3343.8	57.826
53	166.5	2206.1	46.970	65½	205.7	3369.5	58.047
53¼	167.2	2227.0	47.191	65¾	206.5	3395.3	58.269
53½	168.	2248.0	47.413	66	207.3	3421.2	58.490
53¾	168.8	2269.0	47.634	66¼	208.1	3447.1	58.712
54	169.6	2290.2	47.856	66½	208.9	3473.2	58.934
54¼	170.4	2311.4	48.077	66¾	209.7	3499.3	59.155
54½	171.2	2332.8	48.299	67	210.4	3525.6	59.377
54¾	172.	2354.2	48.520	67¼	211.2	3552.0	59.598
55	172.7	2375.8	48.742	67½	212.	3578.4	59.820
55¼	173.5	2397.4	48.964	67¾	212.8	3605.0	60.041
55½	174.3	2419.2	49.185	68	213.6	3631.6	60.263
55¾	175.1	2441.0	49.407	68¼	214.4	3658.4	60.484
56	175.9	2463.0	49.628	68½	215.1	3685.2	60.706
56¼	176.7	2485.0	49.850	68¾	215.9	3712.2	60.928
56½	177.5	2507.1	50.071	69	216.7	3739.2	61.149
56¾	178.2	2529.4	50.293	69¼	217.5	3766.4	61.371
57	179.	2551.7	50.514	69½	218.3	3793.6	61.592
57¼	179.8	2574.1	50.736	69¾	219.1	3821.0	61.814
57½	180.6	2596.7	50.958	70	219.9	3848.4	62.035
57¾	181.4	2619.3	51.179	70¼	220.6	3875.9	62.257
58	182.2	2642.0	51.401	70½	221.4	3903.6	62.478
58¼	182.9	2664.9	51.622	70¾	222.2	3931.3	62.700
58½	183.7	2687.8	51.844	71	223.	3959.2	62.922
58¾	184.5	2710.8	52.065	71¼	223.8	3987.1	63.143
59	185.3	2733.9	52.287	71½	224.6	4015.1	63.365
59¼	186.1	2757.1	52.508	71¾	225.4	4043.2	63.586
59½	186.9	2780.5	52.730	72	226.1	4071.5	63.808
59¾	187.7	2803.9	52.952	72¼	226.9	4099.8	64.029
60	188.4	2827.4	53.173	72½	227.7	4128.2	64.251
60¼	189.2	2851.0	53.395	72¾	228.5	4156.7	64.473
60½	190.	2874.7	53.616	73	229.3	4185.3	64.694
60¾	190.8	2898.6	53.838	73¼	230.1	4214.1	64.916

Diam.	Circum.	Area.	Side of equal square.	Diam.	Circum.	Area.	Side of equal square.
73½	230.9	4242.9	65.137	86	270.1	5808.8	76.215
73¾	231.6	4271.8	65.359	86¼	270.9	5842.6	76.437
74	232.4	4300.8	65.580	86½	271.7	5876.5	76.658
74¼	233.2	4329.9	65.802	86¾	272.5	5910.5	76.880
74½	234.	4359.1	66.023	87	273.3	5944.6	77.101
74¾	234.8	4388.4	66.245	87¼	274.1	5978.9	77.323
75	235.6	4417.8	66.467	87½	274.8	6013.2	77.544
75¼	236.4	4447.3	66.688	87¾	275.6	6047.6	77.766
75½	237.1	4476.9	66.910	88	276.4	6082.1	77.987
75¾	237.9	4506.6	67.191	88¼	277.2	6116.7	78.209
76	238.7	4536.4	67.353	88½	278.	6151.4	78.431
76¼	239.5	4566.3	67.574	88¾	278.8	6186.2	78.652
76½	240.3	4596.3	67.796	89	279.6	6221.1	78.874
76¾	241.1	4626.4	68.017	89¼	280.3	6256.1	79.095
77	241.9	4656.6	68.239	89½	281.1	6291.2	79.317
77¼	242.6	4686.9	68.461	89¾	281.9	6326.4	79.538
77½	243.4	4717.3	68.682	90	282.7	6361.7	79.760
77¾	244.2	4747.7	68.904	90¼	283.5	6397.1	79.981
78	245.	4778.3	69.125	90½	284.3	6432.6	80.203
78¼	245.8	4809.0	69.347	90¾	285.1	6468.2	80.425
78½	246.6	4839.8	69.568	91	285.8	6503.8	80.646
78¾	247.4	4870.7	69.790	91¼	286.6	6539.6	80.868
79	248.1	4901.6	70.011	91½	287.4	6575.5	81.089
79¼	248.9	4932.7	70.233	91¾	288.2	6611.5	81.311
79½	249.7	4963.9	70.455	92	289.	6647.6	81.532
79¾	250.5	4995.1	70.676	92¼	289.8	6683.8	81.754
80	251.3	5026.5	70.898	92½	290.5	6720.0	81.975
80¼	252.1	5058.0	71.119	92¾	291.3	6756.4	82.197
80½	252.8	5089.5	71.341	93	292.1	6792.9	82.419
80¾	253.6	5121.2	71.562	93¼	292.9	6829.4	82.640
81	254.4	5153.0	71.784	93½	293.7	6866.1	82.862
81¼	255.2	5184.8	72.005	93¾	294.5	6902.9	83.083
81½	256.	5216.8	72.227	94	295.3	6939.7	83.305
81¾	256.8	5248.8	72.449	94¼	296.	6776.7	83.526
82	257.6	5281.0	72.670	94½	296.8	7013.8	83.748
82¼	258.3	5313.2	72.892	94¾	297.6	7050.9	83.970
82½	259.1	5345.6	73.113	95	298.4	7088.2	84.191
82¾	259.9	5378.0	73.335	95¼	299.2	7122.5	84.413
83	260.7	5410.6	73.566	95½	300.	7163.0	84.634
83¼	261.5	5443.2	73.778	95¾	300.8	7200.5	84.856
83½	262.3	5476.0	73.999	96	301.5	7238.2	85.077
83¾	263.1	5508.8	74.221	96¼	302.2	7275.9	85.299
84	263.8	5541.7	74.443	96½	303.1	7313.8	85.520
84¼	264.6	5574.8	74.664	96¾	303.9	7351.7	85.742
84½	265.4	5607.9	74.886	97	304.7	7389.8	85.964
84¾	266.2	5641.1	75.107	97¼	305.5	7427.9	86.185
85	267.	5674.5	75.329	97½	306.3	7466.2	86.407
85¼	267.8	5707.9	75.550	97¾	307.	7504.5	86.628
85½	268.6	5741.4	75.772	98	307.8	7542.9	86.850
85¾	269.3	5775.0	75.993	98¼	308.6	7581.5	87.071

Diam.	Circum.	Area.	Side of equal square.	Diam.	Circum.	Area.	Side of equal square.
98½	309.4	7620.1	87.293	99½	312.5	7775.6	88.179
98¾	310.2	7658.8	87.514	99¾	313.3	7814.7	88.401
99	311.	7697.7	87.736	100	314.1	7853.9	88.622
99¼	311.8	7736.6	87.958				

To find, by means of the Table, the square or circle that will contain the area of a board or surface of given length and width.

RULE.—Find the area of the board or surface by multiplying its width by its length, and in the columns opposite the area thus found, headed respectively "*Diam.*," "*Circum.*," and "*Side of Equal Square*," will be found the dimensions of the circle and square that contains the area.

EXAMPLE.—What is the side of a square, and what the diameter and circumference of a circle, that will contain the same area as a board that is 22 inches wide by 12 feet long?

SOLUTION.—22 inches, width, × 144 inches, length, = 3168 square inches, area of board: Then, in the table, opposite the area of 3166.9 (the nearest number to 3168) under the columns headed respectively "Diam.," "Circum.," and "Side of Equal Square," will be found 63½ inches, diameter, 109.4 inches, circumference, and 56.275 inches, side of square. *Ans.*

SQUARES, CUBES, AND ROOTS.

TABLE *of Squares, Cubes, and Square and Cube Roots, of all numbers from* 1 *to* 1000.

No.	Square.	Cube.	Sq. Root,	Cu. Root.	No.	Square.	Cube.	Sq Root.	Cu. Root.
1	1	1	1.	1.	54	2916	157464	7 348469	3.779763
2	4	8	1.414213	1.259921	55	3025	166375	7.416198	3.802953
3	9	27	1.732050	1.442250	56	3136	175616	7.483314	3.825862
4	16	64	2.	1 587401	57	3249	185193	7.549834	3.848501
5	25	125	2.236068	1.709976	58	3364	195112	7.615773	3.870877
6	36	216	2.449489	1.817121	59	3481	205379	7.681145	3.892996
7	49	343	2.645751	1.912933	60	3600	216000	7.745966	3.914867
8	64	512	2.828427	2.	61	3721	226981	7.810249	3.936497
9	81	729	3.	2.080084	62	3844	238328	7.874007	3.957892
10	100	1000	3.162277	2.154435	63	3969	250047	7.937253	3.979057
11	121	1331	3.316624	2.223980	64	4096	262144	8.	4.
12	144	1728	3.464101	2.289428	65	4225	274625	8.062257	4.020726
13	169	2197	3.605551	2.351335	66	4356	287496	8.124038	4.041240
14	196	2744	3.741657	2.410142	67	4489	300763	8.185352	4.061548
15	225	3375	3.872983	2.466212	68	4624	314432	8.246211	4.081655
16	256	4096	4.	2.519842	69	4761	328509	8.306623	4.101566
17	289	4913	4.123105	2.571282	70	4900	343000	8.366600	4 121285
18	324	5832	4.242640	2 620741	71	5041	357911	8.426149	4.140818
19	361	6859	4.358898	2.668402	72	5184	373248	8.485281	4.160168
20	400	8000	4.472136	2.714418	73	5329	389017	8.544003	4.179339
21	441	9261	4.582575	2.758923	74	5476	405224	8.602325	4.198336
22	484	10648	4.690415	2.802039	75	5625	421875	8.660254	4.217163
23	529	12167	4.795831	2.843867	76	5776	438976	8.717797	4.235824
24	576	13824	4.898979	2.884499	77	5929	456533	8.774964	4.254321
25	625	15625	5.	2 924018	78	6084	474552	8.831760	4 272659
26	676	17576	5.099019	2.962496	79	6241	493039	8.888194	4.290841
27	729	19683	5.196152	3.	80	6400	512000	8.944271	4.308870
28	784	21952	5.291502	3.036589	81	6561	531441	9.	4.326749
29	841	24389	5.385164	3.072317	82	6724	551368	9.055385	4.344481
30	900	27000	5.477225	3.107232	83	6889	571787	9.110433	4.362071
31	961	29791	5.567764	3.141381	84	7056	592704	9.165151	4.379519
32	1024	32768	5.656854	3.174802	85	7225	614125	9.219544	4.396830
33	1089	35937	5.744562	3.207534	86	7396	636056	9.273618	3.414005
34	1156	39304	5.830951	3.239612	87	7569	658503	9.327379	4.431047
35	1225	42875	5 916079	3.271066	88	7744	681472	9.380831	4 447960
36	1296	46656	6.	3 301927	89	7921	704969	9.433981	4.464745
37	1369	50653	6.082762	3.332222	90	8100	729000	9.486833	4 481401
38	1444	54872	6.164414	3.361975	91	8281	753571	9.539392	4.497942
39	1521	59319	6.244998	3.391211	92	8464	778688	9.591663	4.514357
40	1600	64000	6.324555	3.419952	93	8649	804357	9 643650	4.530655
41	1681	68921	6.403124	3.448217	94	8836	830584	9.695359	4.546836
42	1764	74088	6.480740	3.476027	95	9025	857375	9.746794	4 562903
43	1849	79507	6.557438	3.503398	96	9216	884736	9.797959	4.577857
44	1936	85184	6.633249	3.530348	97	9409	912673	9.848857	4.594701
45	2025	91125	6.708203	3.556893	98	9604	941192	9.899494	4.610436
46	2116	97336	6.782330	3.583048	99	9801	970299	9.949874	4.626065
47	2209	103823	6.855654	3.608826	100	10000	1000000	10.	4,641589
48	2304	110592	0.928203	3.634241	101	10201	1030301	10.049875	4.657010
49	2401	117649	7.	3.659306	102	10404	1061208	10.099504	4.672330
50	2500	125000	7.071067	3.684031	103	10609	1092727	10.148891	4.687548
51	2601	132651	7.141428	3.708430	104	10816	1124864	10.198039	4.702669
52	2704	140608	7.211102	3.732511	105	11025	1157625	10.246950	4.717694
53	2809	148877	7.280109	3.756286	106	11236	1191016	10.295630	4.732624

No.	Square.	Cube.	Sq. Root.	Cu. Root.	No.	Square.	Cube.	Sq. Root.	Cu. Root.
107	114:9	1225043	10.344080	4.747459	172	29584	5088448	13.114877	5.561:98
10	11 84	1259712	10.392304	4.762203	173	29929	5177717	13.152946	5.57.054
109	1188.	1295 29	10 4 0.06	3.776856	174	30276	5268024	13.190.06	5.582770
110	12 0	133 000	10.488088	4.7914.0	175	30625	5359375	13.228756	5.593445
111	1232	1367631	10.535653	4.805896	176	30976	5451776	13 266499	5.604079
11	12544	1404928	10.583005	4.820284	177	31329	554523	13.304134	5.614673
11	1.769	1442897	10.630145	4.834588	178	31684	5639752	13.341664	5.625228
114	12996	1481544	10.677078	4.848808	179	32 41	5735839	13.379088	5.635741
11	13225	1520875	10.723805	4.862944	180	324 0	583.000	13.416407	5.646216
11	13456	1560896	10.770329	4.876999	181	32761	5929741	13.4536.4	5.656652
117	13689	1601613	10.816653	4.890973	182	33124	6028568	13.490737	5.667051
118	1. 924	1643032	10.862780	4.904868	183	3 489	6128487	13 527749	5.677411
119	14161	1685159	10.908712	4.918685	184	33856	62.9504	13.564660	5.687734
120	14400	1728000	10.954451	4.932424	185	34.25	6331625	13.601470	5.698019
121	14641	177.561	11	4.946088	186	34 96	6434856	13.638181	5.708267
12	14884	1815848	11.045361	4.959675	187	34969	6539203	13.674794	5.718479
12	15129	1860867	11.090536	4.973190	188	35344	664467	13.711309	5.728654
124	15376	1906.21	11.135528	4 986631	189	35721	6751269	13.747727	5.738794
125	15625	1953125	11 180339	5	190	36100	6859000	13.784048	5.748897
126	15876	2000376	11.224972	5.013298	191	36481	6967871	13.820275	5.758965
127	1612	2048383	11 269427	5.026526	192	36864	7077888	13.8564 6	5.768998
128	16384	2097152	11.313708	5.039684	193	37249	7189057	13.892444	5.778996
129	1661	2146 89	11.357816	5.052774	194	37636	7301384	13.928388	5.788960
130	16900	2197000	11 401754	5.065797	195	38 25	7414875	13.964.40	5.798890
131	1716	2248091	11.445523	5.078753	196	38416	7529536	14.	5.808786
132	1742.	2299968	11.489125	5.091643	197	38609	7645373	14.035668	5.818648
13	17689	2352637	11.532562	5.104469	198	39.04	7762392	14.071247	5.828476
13	17 56	2406104	11.575836	5.117230	199	39601	7880599	14.106736	5.838272
135	18225	2460375	11.6 8950	5.129928	200	40000	8000000	14.142136	5.848035
136	18496	2515456	11.661903	5.142563	201	40401	812060	14.177446	5.857765
137	18769	2571353	11.704699	5.155137	202	40804	8242408	14.212670	5.867464
138	19044	262807	11.747344	5.167649	203	41209	8365427	14.247806	5.877130
139	19 2	2685619	11.789826	5.180101	204	41616	8489664	14.282856	5.886765
140	19600	2744000	11.832159	5.192494	205	42025	8615125	14.317821	5.896368
14	19 81	2803221	11 874342	5 204828	206	42436	8741816	14.352700	5.905941
142	20 64	2863288	11.9163 5	5.217103	207	42849	8869743	14.387494	5.915481
143	20449	2924 07	11.958260	5 229321	208	43264	8998912	14.42220.	5.924991
144	20736	2985984	12.	5.241482	209	43681	9123329	14.456832	5.934473
14	21025	3048625	12.041594	5.253588	210	44100	9261000	14.491376	5.943911
146	21316	3112136	12.083046	5.265637	211	44521	9393931	14.525083	5.9 3341
147	2 609	3176523	12 124356	5.277632	212	44944	9528128	14.5602 9	5.962731
148	21904	3241792	12.165525	5.289572	213	45369	9663597	14.5945 9	5.972091
149	2 20	3307949	12.206555	5.301459	214	45796	9800344	14.628738	5.981426
15	2250.	3375000	12.247448	5.313293	215	46225	9938375	14 662878	5.990727
15	22801	3442951	12 288205	5.325074	216	46656	1007789	14.696938	6.
15	231 4	3511808	12.328828	5.336803	217	47089	10218313	14.730919	6.009244
15	23409	3581577	12.369316	5.348481	218	47:24	1030232	14.764823	6.0 8463
154	23716	3652264	12.409673	5 360108	219	47961	1030459	14.798648	6.027650
15	24025	3723875	12.449899	5.371685	220	48400	10648000	14.83239	6.036811
156	24336	3796416	12 489996	5 383231	221	48841	10793861	14.8660 8	6.045943
157	24649	3869893	12.529964	5.394690	222	49284	10941048	14.899664	6.055048
158	24964	39443 2	12.569805	5.406120	223	49729	11089567	14.933184	6.0 4126
159	25281	4019679	12.609520	5.4 7501	224	50176	11239424	14.966629	6.073177
160	2 600	4096000	12.649110	5.428835	225	50625	11390625	15.	6.082201
16	25921	4173281	12 688577	5.440122	226	51076	11543176	15.033296	6.091199
162	26 44	4251528	12.727922	5 451362	227	51529	11697083	15.0 65 9	6.100170
163	26569	4330747	12.767145	5.462556	228	51984	11852352	15 099668	6.109115
164	26896	4410944	12.806248	5.473703	229	52441	12008989	15.13.741	6.118032
16	27225	4492125	12.845232	5.484806	230	52900	12167000	15.165750	6.126925
166	27556	4574296	12.884098	5.495865	231	53361	12326391	15.198684	6.135792
167	27889	4757463	12.922848	5.506879	232	53824	12487168	15.231546	6.144634
168	28224	4741632	12.96148	5.517848	233	54289	12649337	15.264337	6.153449
169	28561	4826809	13.	5.528775	234	54756	12812904	15.297058	6.162239
170	28900	4913000	13.038404	5.539658	235	55225	12977875	15.32970	6.171005
171	29241	5000211	13.076696	5.550499	236	55696	13144256	15.362291	6.179747

No.	Square	Cube.	Sq. Root.	Cu. Root.	No.	Square.	Cube.	Sq. Root.	Cu. Root.
237	56169	13312053	15.394804	6.188463	302	91204	27643608	17.378147	6.709172
238	56644	13481272	15.427248	6.197154	303	91809	27818127	17.406895	6 716569
239	57121	13651919	15 459624	6.205821	304	92416	28094464	17.435596	6.723950
240	57600	13824000	15.491933	6.2 4464	305	93025	2 372625	17.464249	9.731316
241	5608	1399762	15.524174	6.223063	306	93636	28652616	17.492856	6.738665
242	58564	14172488	15.556349	6.231678	307	94249	2893444	17.521415	6.745997
243	59049	1434590.	15.588457	6.240251	308	94864	29218112	17.549928	6.753313
244	595 6	14526784	15.620499	6.248800	309	9548.	29503629	17.578395	6.760614
245	60025	14706125	15.652475	6.257324	310	96100	29791000	17.606816	6.767899
246	60516	1488 936	15.684387	6.265826	311	9672	30080231	17.635192	6.775168
247	61009	1506922	15.716233	6.274304	312	97344	80871328	17.663521	6.782422
248	61504	15252992	15.748015	6.282760	313	97969	80664297	17.691806	6.789661
249	6.001	15438249	15.779733	6.291194	314	98596	80959144	17.7200 6	6.796884
250	62500	1562 000	15.81 388	6.299604	315	99225	81255875	17.748239	6.804091
251	63 01	1581 25	15.842979	6.3 7992	316	99856	81554496	17.776388	6.811284
252	63504	1600 00	15.874507	6.316359	3 7	100489	818550 3	17.804493	6 818461
253	64009	16194277	15.905973	6.324704	318	101124	82157432	17.832554	6.825624
254	64516	16387064	15.937377	6,333 25	319	101761	82461759	17.860571	6.832771
255	65025	16581375	15.968719	6.34 3 6	320	102400	32768000	17.888543	6.839903
256	65 36	1677721	16	6.349602	82	103042	33076161	17.916472	6.847021
257	66049	16974593	6.031219	6 357839	322	103684	83386248	17.944358	6.854124
258	6 564	17173512	16.062378	6 366095	323	104329	83698267	17.972200	6.861211
269	67081	1737397	16.093476	6.374310	324	104976	34012224	18.	6.868284
260	67 00	1757600	16 124515	6.382504	325	105625	34328125	18.027756	6.875343
261	68121	17779581	16.165494	6.390676	326	106276	34645976	18.055470	6.88 388
262	68644	17984728	16.186414	6.398827	327	106929	849 6783	18.083141	6 889419
263	69169	1610 447	16.217274	6.405956	328	107584	85267552	18.110770	6.896435
264	69696	18399744	16.248076	6.415068	329	108241	35611289	18.136357	6.903436
265	7022	18609625	16.27882	6.423157	330	108900	359 7000	18.166902	6.910423
266	70756	18821 9	16.30950	6.431226	331	109561	36264691	18.193405	6.917396
267	71289	19034163	16.340 34	6.439275	332	110224	36594368	18.2 0867	6.924355
268	71824	1924863.	16.370705	6.447305	333	110889	369260 7	18.248287	6.931300
269	72361	19465109	16.40 219	6.455314	33	111556	37259704	18.275666	6.938232
270	72900	196830 0	10.431676	6.463304	335	11 225	37595375	18 30300	.6.945449
271	73441	1990 51	16.462077	6.471274	336	112896	87933056	18.330302	6.952053
272	73984	201 3648	16.49 42	6.479224	337	113569	38272753	18.377559	6.958943
273	7452	20346417	16.522711	6.487158	338	114 44	386144 2	18.384776	6.965819
274	75076	20570824	16.552945	6.495064	339	114 21	38958219	18.411952	6.972652
275	7562	20796875	16.583124	6.502956	340	115600	39304000	18.439088	6.979532
276	76176	21024576	16.613247	6.510829	34	116281	89651821	18.466185	6 986369
277	76729	2125393	16.643317	6.518684	342	116964	40001688	18.493242	6.993491
278	77284	21484952	16.673332	6 526519	343	117649	40353607	18.520 59	7.
279	77841	21717639	16.703293	6.534335	344	118336	40707584	18.547237	7.006796
280	78400	2195200	16.733200	6.542132	345	119025	41063625	18.574175	7.013579
281	78961	22168041	16.763054	6.549411	346	119716	41421736	18.601075	7.020349
28	79524	22425768	16.79285	6.557672	347	120409	41781923	18.627936	7.027106
283	80089	22665187	16.822603	6.565416	348	121104	42144192	18.654758	7.033850
284	6065	2290030	16.852299	6.573139	349	121801	42508549	18.681541	7.040581
285	81225	2314 1 5	16.881943	6.580844	350	122500	42875000	18.708286	7.047208
286	81796	23393656	16.911534	6.588531	351	123201	43243551	18.734994	7.0 4003
28	82369	23639903	16.941074	6.596202	35.	12390-	43614208	18.761063	7.060696
288	82944	23887872	16.970562	6.603854	353	124609	43986977	18.788294	7.067376
289	83521	24137569	17.	6.611488	354	125316	44361864	18.814887	7.074043
290	84100	24389000	17.029386	6.619106	355	126025	44738875	18.841443	7.080698
291	84681	24642171	17.05872.	6.626705	356	126736	45118016	18.867962	7.087341
292	85264	24897088	17.088007	6 634287	357	12 449	45499293	18.894443	7.093970
293	85849	25153757	17.117242	6.641861	358	128164	45882712	18.920887	7.100588
294	8643	254 2184	17.146428	6.649399	359	128881	46268279	18.947295	7.107193
295	870 5	25672375	17.175564	6.656930	360	129600	46656000	18.973666	7.113786
296	87616	26934336	17.204650	6.664443	361	130321	47045881	19.	7.120367
297	88209	26198073	17.233687	6.671940	362	131044	47437928	19.026297	7.126935
298	88804	26463592	17.262676	6.679419	363	131769	47832147	19.05 558	7.133492
299	89401	26730899	17.291616	6.686882	364	13249	48228544	19.078784	7.140037
300	90 00	27000000	17.320 08	6.694328	366	133225	48627125	19.104973	7.146569
301	90601	27270901	17.349361	6.701758	366	133956	49027896	19.131126	7.153090

No.	Square.	Cube.	Sq. Root.	Cu. Root.	No.	Square.	Cube.	Sq. Root.	Cu. Root.
367	134689	49430863	19.157244	7.159599	432	186624	80621568	20.784610	7.559525
366	135424	4983603.	19.183520	7.166095	433	187489	81182737	20.808652	7.565343
369	136161	50243409	19.209373	7.172480	434	188356	81746504	20.832666	7.571173
370	136900	50653000	19.235384	7.179064	435	189226	82312875	20.856653	7.576984
371	137641	51064811	19.261360	7.185516	436	190096	82881656	20.880613	7.582786
372	138384	51478848	19.287301	7.191966	437	496969	83453453	20.804545	7.588579
373	139129	5189511	19.313207	7.198405	438	191844	84027672	20.928449	7.594363
374	139876	52313624	19.339079	7.204832	439	192721	84604519	20.952326	7.600138
375	140625	52734375	19.364916	7.211247	440	193600	85184000	20.976177	7.605906
376	141376	53157376	19.390719	7.217652	441	194481	85766121	21.	7.611662
377	142129	53582633	19.416487	7.224045	442	195364	86350388	21.023796	7.617411
378	142884	54010152	19.442222	7.230427	443	196249	86938307	21.047565	7.623161
379	143641	54439939	19.467922	7.236797	444	197136	87528384	21.071307	7.628883
380	144400	54872000	19.493588	7.243156	445	19802	88121125	21.095023	7.634006
381	145161	55306341	19.519221	7.249504	446	198916	88716536	21.118712	7.640321
382	145924	55742968	19.544820	7.255841	447	199809	89314623	21.142374	7.646027
383	146689	56181887	19.570385	7.262167	448	200704	89915392	21.166010	7.651726
384	147456	56623104	19.595917	7.268482	449	201601	90518849	21.189620	7.657414
385	148225	57066625	19.62141	7.274786	450	202500	91125000	21.213203	7.663094
386	148996	57512456	19.646882	7.281079	451	20340	91733851	21.236760	7.668766
387	149769	57960603	19.672316	7.287362	452	204304	92345408	21.260291	7.674430
388	150544	58411072	19.697715	7.293633	453	205209	92959677	21.283796	7.660085
389	151321	5886386	19.723082	7.299893	454	206106	93576664	21.307276	7.686732
390	152100	59319000	19.748417	7.306143	455	207025	94196375	21.330729	7.691371
391	152881	59776471	19.773719	7.312383	456	20793	94818816	21.354156	7.697002
392	153664	60236288	19 798989	7.318611	457	208849	95443993	21.377558	7.702624
39	154449	60698457	19.824226	7.324829	458	209764	96071912	21.400934	7.708238
394	155236	61162984	19.849432	7.331037	459	210681	96702579	21.424 85	7.713844
395	156025	61629875	19.874606	7.337234	460	211600	97336000	21.447610	7.719442
396	156816	62099136	19.899748	7.343420	461	212521	97972181	21.470910	7.725032
397	157609	62570773	19 924858	7.349596	462	213444	98611128	21.494185	7.730614
398	158404	63044792	19.949937	7.365762	46	214369	99262847	21.517434	7.736167
399	159201	63521199	19.974984	7.361917	464	215296	99897344	21.540659	7.741753
400	160000	6400000	20.	7.368063	466	216226	100544625	21.563868	7.747310
401	160601	64481201	20.024984	7.374198	46	217156	101194696	21.587033	7.752860
402	161604	6496480	20.049937	7.380322	467	218089	101847563	21.610182	7.758402
40	162409	65450827	20 074859	7.386437	468	219024	102503232	21.633307	7.763936
404	163216	65939264	20.099751	7.392542	469	219961	103161709	1.656407	7.769462
405	164025	66430125	20.12461	7.398636	476	220900	103823000	21.679483	7.774980
406	164836	66923416	20.149441	7.401720	471	22184	104487111	21.702534	7.780490
407	165649	67419143	20.174241	7.410794	472	222784	106154048	21.725561	7.786992
408	166464	67911312	20.19900	7.416859	473	223729	105823817	21.748563	7.791487
409	167281	68417929	20.223748	7.422914	474	224676	106496424	21.771541	7.796974
410	168100	68921000	20.248456	7.428958	475	225625	107171876	21 794494	7.802468
411	168921	69426531	20.273134	7 434993	476	226576	107850176	21.817424	7.807926
412	169744	69934528	20.297783	7.441018	477	22752	108531333	21 840.29	7 8.3389
413	170569	.70444997	20.322401	7.447033	478	228484	109215352	21.863211	7.818646
414	171396	70957944	20.346989	7.453039	479	229441	109902239	21.886069	7.824294
415	172226	71473375	20.371549	7.459036	480	230400	110592000	21.908962	7.829736
416	173056	71991296	20.396078	7.465022	481	231361	111284641	21.931712	7.835163
417	173889	72511713	20.420577	7.470939	482	232324	111980168	21.954498	7.840594
418	174724	73034632	20.445048	7.476966	483	233289	112678587	.1.977261	7.846013
419	175561	73560059	20.469489	7.482924	484	234256	113379904	22.	7.851424
4 0	176400	74088000	20.493901	7.488372	485	235225	114084125	22.022715	7.856828
421	177241	74618461	20.518284	7.494810	486	236196	114791256	22.045407	7.862224
422	178084	75151448	20.542638	7.500740	487	237169	115501303	22.068076	7.867618
423	178929	75686967	20.566963	7.506660	488	238144	116214272	2.090722	7.872994
424	179776	76225024	20 591260	7.512571	489	239121	116930169	22.113344	7.878368
425	180625	76765625	20.615528	7 518473	490	240100	117649000	22.135943	7.883734
428	181476	77308776	20.639767	7.524365	491	241081	118370771	22.158519	7.889094
427	182329	77854483	20.663978	7.530248	492	242064	119095488	22.181073	7.894446
428	183184	78402752	20.688160	7.536121	493	243049	119623157	22.203603	7.899791
429	184041	78953589	20.712315	7.541986	494	244036	120555784	22.226110	7.905129
430	184900	79507000	20.736441	7.547841	495	24502	12 287375	22.248594	7.910460
431	185761	80062991	20.760539	7.553688	496	246016	122023936	22.271057	7 915784

No.	Square.	Cube.	Sq. Root.	Cu. Root.	No.	Square.	Cube.	Sq. Root.	Cu. Root.
497	247009	122763473	22.293496	7.921100	562	315844	177504328	23.706539	8.252371
498	248004	123505992	22.315913	7.926408	563	316969	178453547	23.727621	8.257263
499	249001	124251499	22.338307	7.931710	564	318096	179406144	23.748684	8.262149
500	250000	125000000	22.360679	7.937005	565	319225	180362125	23.769728	8.267029
501	251001	125751501	22.383029	7.942293	566	320356	181321496	23.790754	8.271903
502	252004	126506008	22.40535	7.947573	567	321489	182284263	23.811761	8.276772
503	253009	127263527	22.427661	7.952847	568	322624	183250432	23.832750	8.281635
504	254016	128024064	22.449944	7.958114	569	323761	184220009	23.853721	8.286493
505	255025	128787625	22.472205	7.963374	570	324900	185193000	23.874672	8.291344
506	256036	129554216	22.494444	7.968627	571	326041	186169411	23.895606	8.296190
507	257049	130323843	22.516660	7.973873	572	327184	187149248	23.916521	8.301030
508	258064	131096512	22.538855	7.979112	573	328329	188132517	23.937418	8.305865
509	259081	131872229	22.561028	7.984344	574	329476	189119224	23.958297	8.310694
510	260100	132651000	22.583179	7.989569	575	330625	190109375	23.979157	8.315517
511	261121	133432831	22.605309	7.994788	576	331776	191102976	24.	8.320335
512	262144	134217728	22.627417	8.	577	332929	192100033	24.020824	8.325147
513	263169	135005697	22.649503	8.005205	578	334084	193100552	24.041630	8.329954
514	264196	135796744	22.671568	8.010403	579	335241	194104539	24.062419	8.334755
515	265225	136590875	22.693611	8.015595	580	336400	195112000	24.083189	8.339551
516	266256	137388096	22.715633	8.020779	581	337561	196122941	24.103941	8.344341
517	267289	138188413	22.737634	8.025957	582	338724	197137368	24.124676	8.349126
518	268324	138991832	22.759613	8.031129	583	339889	198155287	24.145392	8.353904
519	269361	139798359	22.781571	8.036293	584	341056	199176704	24.166091	8.358678
520	270400	140608000	22.803509	8.041451	585	342225	200201625	24.186773	8.363446
521	271441	141420761	22.825424	8.046603	586	343396	201230056	24.207436	8.368209
522	272484	142236648	22.847319	8.051748	587	344569	202262003	24.228082	8.372966
523	273529	143055667	22.869193	8.056886	588	345744	203297472	24.248711	8.377719
524	274576	143877824	22.891046	8.062018	589	346921	204336469	24.269322	8.382465
525	275625	144703125	22.912878	8.067143	590	348100	205379000	24.289915	8.387206
526	276676	145531576	22.934689	8.072262	591	349281	206425071	24.310491	8.391942
527	277729	146363183	22.956481	8.077374	592	350464	207474688	24.331050	8.396673
528	278784	147197952	22.978251	8.082480	593	351649	208527857	24.351591	8.401398
529	279841	148035889	23.	8.087579	594	352836	209584584	24.372116	8.406118
530	280900	148877000	23.021729	8.092672	595	354025	210644875	24.392621	8.410832
531	281961	149721291	23.043437	8.097759	596	355216	211708736	24.413111	8.415541
532	283024	150568768	23.065125	8.102839	597	356409	212776173	24.433583	8.420246
533	284089	151419437	23.086793	8.107912	598	357604	213847192	24.454038	8.424944
534	285156	152273304	23.108440	8.112980	599	358801	214921799	24.474476	8.429638
535	286225	153130375	23.130067	8.118041	600	360000	216000000	24.494897	8.434327
536	287296	153990656	23.151674	8.123096	601	361201	217081801	24.515301	8.439009
537	288369	154854153	23.173260	8.128144	602	362404	218167208	24.535688	8.443687
538	289444	155720872	23.194827	8.133186	603	363609	219256227	24.556058	8.448360
539	290521	156590819	23.216373	8.138223	604	364816	220348864	24.576411	8.453027
540	291600	157464000	23.237900	8.143253	605	366025	221445125	24.596747	8.457689
541	292681	158340421	23.259407	8.148276	606	367236	222545016	24.617067	8.462347
542	293764	159220088	23.280893	8.153293	607	368449	223648543	24.637370	8.466999
543	294849	160103007	23.302360	8.158305	608	369664	224755712	24.657656	8.471647
544	295936	160989184	23.323807	8.163310	609	370881	225866529	24.677925	8.476289
545	297025	161878625	23.345235	8.168308	610	372100	226981000	24.698178	8.480926
546	298116	162771336	23.366643	8.173302	611	373321	228099131	24.718414	8.485557
547	299209	163667323	23.388031	8.178289	612	374544	229220928	24.738634	8.490184
548	300304	164566592	23.409400	8.183269	613	375769	230346397	24.758836	8.494806
549	301401	165469149	23.430749	8.188244	614	376996	231475544	24.779023	8.499423
550	302500	166375000	23.452078	8.193212	615	378225	232608375	24.799193	8.504031
551	303601	167284151	23.473389	8.198175	616	379456	233744896	24.819347	8.508641
552	304704	168196608	23.494680	8.203131	617	380689	234885113	24.839484	8.513243
553	305809	169112377	23.515952	8.208082	618	381924	236029032	24.859605	8.517840
554	306916	170031464	23.537204	8.213027	619	383161	237176659	24.879710	8.522432
555	308025	170953875	23.558438	8.217965	620	384400	238328000	24.899799	8.527018
556	309136	171879616	23.579652	8.222898	621	385641	239483061	24.919871	8.531600
557	310249	172808693	23.600847	8.227825	622	386884	240641848	24.939927	8.536177
558	311364	173741112	23.622023	8.232746	623	388129	241804367	24.959967	8.540749
559	312481	174676879	23.643181	8.237661	624	389376	242970624	24.979992	8.545317
560	313600	175616000	23.664319	8.242570	625	390625	244140625	25.	8.549879
561	314721	176558481	23.685438	8.247474	626	391876	245314376	25.019992	8.554437

No.	Square.	Cube.	Sq. Root.	Cu. Root.
627	393129	246491883	25.039968	8.558990
628	394384	247673152	25.059928	8.563237
629	395641	248858189	25.079872	8.565058
630	396900	250047000	25.099800	8.572618
631	398161	251239591	25.119713	8.577152
632	399424	252435968	25.139610	8.581680
633	400689	253636137	25.16949	8.586204
634	401956	254840104	25.179356	8.590723
635	403225	256047875	25.199206	8.595238
636	404496	257259456	25.219040	8.6997 7
637	405769	258474853	25.238858	8.604252
638	407044	259694072	25.258661	8.608752
639	408321	260917119	25.278449	8.613248
640	409600	262144000	25.29822	8.617738
641	410881	263374721	25.317977	8.622224
642	412164	264609288	25.33771	8.626706
643	413449	265847707	25.357444	8.631183
644	414736	267089984	25.377155	8.635655
645	416025	268336125	25.396850	8.640122
646	417316	269586136	25.416530	8.644585
647	418609	270840023	25.436194	8.649043
648	419904	272097792	25.455844	8.653497
649	421201	273359449	25.475478	8.657946
650	422500	274625000	25.495098	8.662391
651	423801	275894451	25.514701	8.666831
652	425104	277167808	25.53429	8.671266
653	426409	278445977	25.553864	8.675697
654	427716	279726264	25.573423	8.680123
655	429025	281011375	25.59296	8.684545
656	430336	282300416	25.612496	8.688963
657	431649	283593393	25.632011	8.693376
658	432964	284890312	25.651510	8.697784
659	434281	286191179	25.670995	8.702188
660	435600	287496000	25.690465	8.796587
661	436921	288804781	25.709920	8.710982
662	438244	290117528	25.729360	8.715373
663	439569	291434247	25.748786	8.719759
664	440896	292754944	25.768197	8.724141
665	442225	294079625	25.787593	8.728518
666	443556	295408296	25.806975	8.732891
667	444889	296740963	25.826343	8.737260
668	446224	298077632	25.845696	8.741621
669	447561	299418309	25.865034	8.745984
670	448900	300763000	25.884358	8.750340
671	450241	302111711	25.903667	8.754691
672	451584	303464448	25.922962	8.759038
673	452929	304821217	25.942243	8.763380
674	454276	306182024	25.961510	8.767719
675	455625	307546875	25.980762	8.772053
676	456976	308915776	26.	8.776382
677	458329	310288733	26.019223	8.780708
678	459684	311665752	26.038433	8.785029
679	461041	313046839	26.057628	8.789346
680	462400	314432000	26.076809	8.793659
681	463761	315821241	26.095976	8.797967
682	465124	317214568	26.115129	8.80227
683	466489	318611987	26.134268	8.806572
684	467856	320013504	26.153393	8.810868
685	469225	321419125	26.172504	8.815159
686	470596	322828856	26.191601	8.819447
687	471969	324242703	26.210684	8.823730
688	473344	325660672	26.229754	8.828009
689	474721	327082769	26.248809	8.832285
690	476100	328509000	26.267851	8.836556
691	477481	329939371	26.286878	8.840822
692	478864	331373888	26.305893	8.845085
693	480249	332812557	26.324893	8.849344
694	481636	334255384	26.343879	8.853598
695	483025	335702375	26.362852	8.857849
696	484416	337153536	26.381811	8.862095
697	485809	338608873	26.400757	8.866337
698	487204	340068392	26.419689	8.870575
699	488601	341532099	26.438608	8.874809
700	490000	343000000	26.457513	8.879040
701	491401	344472101	26.476404	8.883266
702	492804	345948408	26.495283	8.887488
703	494209	347428927	26.514147	8.891706
704	495616	348913664	26.53299	8.895920
705	497025	350402625	26.551836	8.900130
706	498436	351895816	26.570661	8.904336
707	499849	353393243	26.589471	8.008538
708	501264	354894912	26.608269	8.912736
709	502681	356400829	26.627053	8.916931
710	504100	357911000	26.645825	8.921121
711	505521	359425431	26.664583	8.925307
712	506944	360944128	26.683328	8.929490
713	508369	362467097	26.702059	8.933668
714	509796	363994344	26.720778	8.937843
715	511225	365525875	26.739483	8.942014
716	512656	367061696	26.758176	8.946180
717	514089	368601813	26.776856	8.950343
718	515524	370146232	26.795522	8.954502
719	516961	371694959	26.814175	8.958658
720	518400	373248000	26.83281	8.962809
721	519841	374805361	26.851443	8.966957
722	521284	376367048	26.870057	8.971100
723	522729	377933067	26.888659	8.975240
724	524176	379503424	26.907248	8.979376
725	525625	381078125	26.925824	8.983508
726	527076	382657176	26.944387	8.987637
727	528529	384240583	26.96293	8.991762
728	529984	385828352	26.98147	8.995883
729	531441	387420489	27.	9.
730	532900	389017000	27.018512	9.004113
731	534361	390617891	27.037011	9.008223
732	535824	392223168	27.055498	9.012329
733	537289	393832837	27.073972	9.016430
734	538756	395446904	27.092434	9.020529
735	540225	397065375	27.110883	9.024623
736	541696	398688256	27.129319	9.028714
737	543169	400315553	27.147743	9.032802
738	544644	401947272	27.166166	9.036885
739	546121	403583419	27.184554	9.040965
740	547600	405224000	27.202941	9.045041
741	549081	406869021	27.221316	9.049114
742	550564	408518488	27.239677	9.053183
743	552049	410172407	27.258026	9.057248
744	553536	411830784	27.276363	9.061309
745	555025	413493625	27.294688	9.065367
746	556516	415160936	27.313000	9.069422
747	558009	416832723	27.331300	9.073472
748	559504	418508992	27.349588	9.077519
749	561001	420189749	27.367864	9.081563
750	562500	421875000	27.386127	9.085603
751	564001	423564751	27.404379	9.089639
752	565504	425259008	27.422618	9.093672
753	567009	426957777	27.440845	9.097701
754	568516	428661064	27.459060	9.101726
755	570025	430368875	27.477263	9.105748
756	571536	432081216	27.495454	9.109766

No.	Square.	Cube.	Sq. Root.	Cu. Root.
757	573049	433798093	27.513633	9.113781
758	574564	435519512	27.531799	9.117793
759	576081	437245479	27.549955	9.121801
760	577600	438976000	27.568097	9.125805
761	579121	440711081	27.586228	9.129806
762	580644	442450728	27.604347	9.133803
763	582169	444194947	27.622454	9.137797
764	583696	445943744	27.640549	9.141788
765	585225	447697125	27.658633	9.145774
766	586756	449455096	27.676706	9.149757
767	588289	451217663	27.694764	9.153737
768	589824	452984832	27.712812	9.157713
769	591361	454756609	27.730849	9.161686
770	592900	456533000	27.748873	9.165656
771	594441	458314011	27.766886	9.169622
772	595984	460099648	27.784888	9.173585
773	597529	461889917	27.802877	9.177544
774	599076	463684824	27.820855	9.181500
775	600625	465484375	27.838821	9.185452
776	602176	467288576	27.856776	9.189401
777	603729	469097433	27.874719	9.193347
778	605284	470910952	27.892651	9.197289
779	606841	472729139	27.910571	9.201228
780	608400	474552000	27.928480	9.205164
781	609961	476379541	27.946377	9.209096
782	611524	478211768	27.964262	9.213025
783	613089	480048687	27.982137	9.216950
784	614656	481890304	28.	9.220872
785	616225	483736625	28.017851	9.224791
786	617796	485587656	28.035691	9.228706
787	619369	487443403	28.053520	9.232618
788	620944	489303872	28.071337	9.236527
789	622521	491169069	28.089143	9.240433
790	624100	493039000	28.106938	9.244335
791	625681	494913671	28.124722	9.248234
792	627264	496793088	28.142494	9.252130
793	628849	498677257	28.160256	9.256022
794	630436	500566184	28.178005	9.259911
795	632025	502459875	28.195744	9.263797
796	633616	504358336	28.213472	9.267679
797	635209	506261573	28.231188	9.271559
798	636804	508169592	28.248893	9.275435
799	638401	510082399	28.266588	9.279308
800	640000	512000000	28.284271	9.283177
801	641601	513922401	28.301943	9.287044
802	643204	515849608	28.319604	9.290907
803	644809	517781627	28.337254	9.294767
804	646416	519718464	28.354893	9.298623
805	648025	521660125	28.372521	9.302477
806	649636	523606616	28.390139	9.306327
807	651249	525557943	28.407746	9.310175
808	652864	527514112	28.425340	9.314019
809	654481	529475129	28.442925	9.317859
810	656100	531441000	28.460498	9.321697
811	657721	533411731	28.478061	9.325532
812	659344	535387328	28.495613	9.329363
813	660969	537367797	28.513154	9.333191
814	662596	539353144	28.530685	9.337016
815	664225	541343375	28.548204	9.340838
816	665856	543338496	28.565713	9.344657
817	667489	545338513	28.583211	9.348473
818	669124	547343432	28.600699	9.352285
819	670761	549353259	28.618176	9.356095
820	672400	551368000	28.635642	9.359901
821	674041	553387661	28.653097	9.363704

No.	Square.	Cube.	Sq. Root.	Cu. Root.
822	675684	555412248	28.670542	9.367505
823	677329	557441767	28.687976	9.371302
824	678976	559476224	28.705400	9.375096
825	680625	561515625	28.722813	9.378887
826	682276	563559976	28.740216	9.382675
827	683929	565609283	28.757608	9.386460
828	685584	567663552	28.774989	9.390241
829	687241	569722789	28.792360	9.394020
830	688900	571787000	28.809720	9.397796
831	690561	573856191	28.827070	9.401569
832	692224	575930368	28.844410	9.405338
833	693889	578009537	28.861739	9.409105
834	695556	580093704	28.879058	9.412869
835	697225	582182875	28.896366	9.416630
836	698896	584277056	28.913664	9.420387
837	700569	586376253	28.930952	9.424141
838	702244	588480472	28.948229	9.427893
839	703921	590589719	28.965496	9.431642
840	705600	592704000	28.982753	9.435388
841	707281	594823321	29.	9.439130
842	708964	596947688	29.017236	9.442870
843	710649	599077107	29.034462	9.446607
844	712336	601211584	29.051678	9.450341
845	714025	603351125	29.068884	9.454071
846	715716	605495736	29.086079	9.457799
847	717409	607645423	29.103264	9.461524
848	719104	609800192	29.120439	9.465247
849	720801	611960049	29.137604	9.468966
850	722500	614125000	29.154759	9.472682
851	724201	616295051	29.171904	9.476396
852	725904	618470208	29.189039	9.480106
853	727609	620650477	29.206163	9.483813
854	729316	622835864	29.223278	9.487518
855	731025	625026375	29.240383	9.491219
856	732736	627222016	29.257477	9.494918
857	734449	629422793	29.274562	9.498614
858	736164	631628712	29.291637	9.502307
859	737881	633839779	29.308701	9.505998
860	739600	636056000	29.325756	9.509685
861	741321	638277381	29.342801	9.513369
862	743044	640503928	29.359836	9.517051
863	744769	642735647	29.376861	9.520730
864	746496	644972544	29.393876	9.524406
865	748225	647214625	29.410882	9.528079
866	749956	649461896	29.427877	9.531749
867	751689	651714363	29.444863	9.535417
868	753424	653972032	29.461839	9.539081
869	755161	656234909	29.478805	9.542743
870	756900	658503000	29.495762	9.546402
871	758641	660776311	29.512709	9.550058
872	760384	663054848	29.529646	9.553712
873	762129	665338617	29.546573	9.557363
874	763876	667627624	29.563491	9.561010
875	765625	669921875	29.580398	9.564655
876	767376	672221376	29.597297	9.568297
877	769129	674526133	29.614185	9.571937
878	770884	676836152	29.631064	9.575574
879	772641	679151439	29.647934	9.579208
880	774400	681472000	29.664793	9.582839
881	776161	683797841	29.681644	9.586466
882	777924	686128968	29.698484	9.590093
883	779689	688465387	29.715315	9.593716
884	781456	690807104	29.732137	9.597337
885	783225	693154125	29.748949	9.600954
886	784996	695506456	29.765752	9.604569

No.	Square	Cube.	Sq. Root.	Cu. Root.	No.	Square.	Cube.	Sq. Root.	Cu. Root.
887	786769	697864103	29.782645	9.608181	944	891136	841232384	30.724583	9.800736
888	788544	700227072	29.799329	9.611791	945	893025	843908625	30.740852	9.813148
889	790321	702595369	29.816103	9.615397	946	894916	846590536	30.757113	9.816559
890	792100	704969000	29.832867	9.619001	947	896809	849278123	30.773365	9.820117
891	793881	707347971	29.849623	9.622603	948	898704	851971392	30.789609	9.823572
892	795664	709732288	29.866369	9.626201	949	900601	854670349	30.805844	9.827025
893	797449	712 21957	29.88310	9.629797	950	902500	857375000	30.822070	9.830475
894	799236	714516984	29.899832	9.633390	951	904401	860085351	30.838288	9.833923
895	801025	716917375	29.916 9	9.636981	9 2	906304	862801408	30.854497	9.837369
896	802816	719323136	29.933259	9.640 69	953	908209	865523177	30.870698	9 840812
897	804609	721734273	29.949958	9.644154	954	910116	868250664	30.886890	9.844253
898	806404	724150792	29.966648	9.647736	95	912025	870983875	30.90 074	9 847692
899	808210	726572699	29.983328	9.651316	95	913936	873722816	30 919249	9.851128
900	810000	7.90000 0	0.	9.654893	95	915849	876467493	30.935416	9.854561
901	811801	731432701	30.016662	9.658468	958	917764	879217912	30.95 57	9.857992
902	813604	733870808	30.033314	9.66 040	959	919681	881974079	30.967725	9.861421
903	815400	736314327	30.049958	9.665609	96	921600	884736000	30.983800	9 864848
904	817216	738763264	30.06659	9.669176	961	92352	887503681	31.	9.868 72
905	819025	741217625	30 083217	9.672740	962	92544	890277128	31.016124	9.871694
906	820836	743677416	30.099833	9.676301	9	927369	893056347	31.032241	9 875113
907	822649	746142613	30 116440	9.679860	96	92929	895841344	31.048349	9.878530
908	82446	748613312	0.133038	9.683416	96	93122	898632125	31.0 4440	9.881946
909	826281	751089429	30.149 26	9.686970	966	9 316	901428 [illegible]	31.080540	9.885357
910	82810	753571000	30.16 200	9.690521	96	935089	904231063	31.096623	9.868767
911	82992	756058021	30.182776	9.694069	968	93702	907039232	1.11 69	9.892174
91	831744	758550528	30.1993 7	9.697615	96	938961	909853209	31.128764	9 895580
913	833 6	761048497	30.216089	9.701158	9.0	940900	912673 00	31.14482	9.898983
914	83 39	763551944	30.232432	9.704698	97	94 841	915498611	31.160872	9.902383
915	837225	76 060875	30.248966	9.708236	97	944784	9183 048	31.178914	9 905781
916	839056	7685 5 96	30.266491	9.711772	97	946729	921167317	31 19 947	9.909177
917	84 889	771095213	30.282007	9.715305	974	948676	924010424	31.20897	9.91 571
918	842724	773620632	0.298514	9.7 8836	97	950625	926859375	31.22 9	9.915962
919	81466	776151559	30.31401	9.722363	976	952576	929714176	31.240998	9.919351
920	846400	778688000	30.331501	9.725888	977	954529	932574833	31.256999	9.922738
921	84824	781229961	30.347981	9.72941	978	956484	935441352	31 27 991	9.9261 2
922	850 84	783777448	30.364452	9.7329 0	979	95844	938313739	31.288975	9.929504
923	85192	7863 0467	30.380915	9.736448	9 0	96 40	941192000	31.3 49	0.932883
924	8537 6	788889024	30.397368	9.739963	9	962 6	944076141	31.3 0919	9.93 261
925	855625	791453125	0.413 1	9.743475	98	96432	946966168	31 3 687	9.939636
926	857476	794022776	30.4 0248	0.746985	983	966289	94986 087	31.352	9.943009
927	859329	79 597983	0.440674	9 750493	984	9 8 56	952763904	31.368774	9.946379
928	86118	799178752	0.48309	0 753998	9	970225	955671625	1.384708	9.949747
929	86304	801765 89	30.47950	9.767 00	980	972196	9 85 52 6	31.400636	9.9531 3
930	86490	804357000	9.49591	9.761009	987	974169	961504803	31.416 56	9.956477
931	86676	8 6954491	30.512 92	9.764497	988	976144	964430272	31.432467	0.969839
932	86862	809557568	30.528675	9.767194	989	978121	967361669	31.448370	9.963198
933	870489	812160237	30.545048	9 771484	99	980100	970 99000	31 464265	9.966554
934	872356	814780504	30.56141	9 774974	991	98 081	973242 71	31 480152	9.969909
935	87422	817400375	30.677769	9.778461	99	98406	976191488	31.4969 1	9.97 262
936	876096	820025858	30.594 17	0 782946	99	986049	979146057	31.51 902	9.976612
937	877969	822656953	0.6104 5	9.785928	994	988036	982107784	31.527765	0.979959
938	879844	825293672	30.6 6785	9.788909	9 5	990025	985074876	1.6436	9.983304
939	88172	82793 019	30.643106	9.79 388	99	99 01	988047936	31.559467	9.986648
940	883600	830584000	30.659419	9.795661	997	994009	991026973	31.575 96	9 989990
941	88548	833237621	30.67572	9.799333	998	996004	994011992	31.591138	9.993328
942	887364	835896888	0.692018	9.802803	999	99800	997 02999	31.606961	9.996665
943	88924	838561807	30.708305	9.80 271	1000	1000000	1000000000	31.622778	10.

THE SOIL.

The soil is made up of decomposed rocks and decayed or decaying organic matter. The proportion of organic matter is small—not averaging in fertile soils more than five per cent. All of the rest of the soil is of a mineral origin, and has at some period formed a part of the rocky crust of the earth.

By the action of air, and heat, and frost, and the friction of running and falling water, and the movement of rocks and stones in moving water, these substances have been sufficiently pulverized to form the foundation material of our present soil.

During uncounted ages these processes have been going on, and they are still active; and, in addition to these, the chemical changes which result from the exposure of pulverized mineral matter to the action of air and moisture, and the successive growth and decay of plants, have operated, and are still operating, to ripen the soil to our uses.

In the early ages, when perhaps the composition of the atmosphere was different from what it is now (and when the soil was surely very different), only plants of a low order, such as are now extinct, could grow at all. These absorbed certain matters from the atmosphere, and, on their decay, gave them to the soil,—thus helping to fit it for the growth of a higher order of plants, which were in time succeeded by others, and those by others, until, finally, the changes effected in the soil by the action of the chemical forces, and by the deposit of vegetable matter, have enabled it to produce the vegetation required for the uses of man.

Classification of soils.

Some soils were formed mainly of the rocks on which they now lie—as those of the granite region of New England—and these take their names from these rocks, as *granitic* soil, *limestone* soil, *sandstone* soil, &c.

Others have been formed by the deposit, by means of great floods, or the gradual silting of rivers. The latter of these (as the flat lands of the Mississippi Valley) are called *alluvial* soils; and the former (comprising those soils of varied composition in which occur clay, gravel, boulders, &c.) are called *diluvial* soils.

Another classification, which is much more definite, is the following:—

1. Pure Clay consists of about 60 per cent. of silica and 40 per cent. of alumina and oxide of iron, usually chemically combined.

2. Strongest Clay Soil consists of pure clay, mixed with 5 to 15 per cent. of silicious sand.

3. Clay Loam consists of pure clay, mixed with 15 to 30 per cent. of fine sand.

4. Loamy Soil deposits from 30 to 60 per cent. of sand.

5. Sandy Loam deposits from 60 to 90 per cent. of sand.

6. Sandy Soil contains no more than 10 per cent. of pure clay.

To analyze the above soils with a view to classifying them.

Rule.—Weigh a portion of the soil and spread it thinly on writing paper, and dry it for an hour or two in an oven, the heat of which is not great enough to discolor the paper —the loss of weight is the quantity of *water* it contained.

Weigh and then boil another equal portion, and when thoroughly incorporated with the water, pour it into a vessel, and allow the sandy parts to deposit until the fine clay is also beginning to settle; then pour off the water, collect the sand, dry as before, and again weigh, which will give the per cent. of *sand* it contained.

The above classification and analysis of soils have reference only to the water, clay, and sand which they contain, while lime is also an important constituent, of which they are rarely entirely destitute. This gives rise to a further classification.

7. Marly Soil is one in which the proportion of lime is more than 5, and not over 20 per cent. of the whole weight.

8. Calcareous Soil, in which the lime exceeds 20 per cent.

To analyze marly and calcareous soils, with a view to their classification as above.

Rule.—Mix 100 grains of the dry soil with half a pint of water, and add half a wine-glassful of muriatic acid; stir it thoroughly during the day, and let it stand and settle over night. Pour off the clear liquid in the morning, and again fill the vessel with water and stir thoroughly, and when clear again pour it off; dry the soil and weigh it. The loss is the quantity of lime the soil contained. If it exceeds 5 grs., class as a *marly soil;* if more than 20 grs., class as a *calcareous soil.*

9. VEGETABLE MOULDS, which are of various kinds, containing from 15 to 60 or 70 per cent. of organic matter.

To analyze vegetable moulds, with a view to their classification as above.

RULE.—Dry the soil well in an oven, and weigh it; then heat it to a dull redness, over a lamp or bright fire, until the combustible matter is burned away and evaporated. Again weigh it, and the loss is the quantity of organic matter it contained.

Besides the foregoing ingredients, every soil must contain more or less of all the elements which enter into the composition of vegetation. They must hold, in a form adapted to its growth and support, *silex*, *alumina*, *carbonate of lime*, *sulphate of lime*, *potash*, *soda*, *magnesia*, *sulphur*, *phosphorus*, *oxide of iron*, *manganese*, *chlorine*, and, probably, *iodine.* They are called the "inorganic or earthy parts of soil," and constitute from one-half of one per cent. to over ten per cent. of all vegetables. Their analysis is too difficult and complicated to be attempted by any but a practical agricultural chemist.

The value of soil analysis, even when made by the most careful and skilful chemists, is practically very little. The quantity of matter which is capable of affording food to plants is so very small, in proportion to the whole bulk of the soil, even in those of the most fertile character, that it is questionable whether a sample to be analyzed could be so carefully prepared as to represent the average character of the whole field. Then, again, if we were to procure a correct analysis of a very fertile soil, and then were to crop it for a series of years without manure until it refused to produce paying crops, and were to have it analyzed again, it is not likely that the chemist would detect any change in its composition. In like manner, if we were to add to it 500 lbs. to the acre of bone dust,—enough to make it produce abundantly,—analysis would fail to detect the small quantity of phosphate of lime that we had added in the bones.

Another argument against the value of the analysis of the soil, and a very strong one, is found in the fact that the fertility of the soil depends less on the *quantity* of plant food that it contains than on its *condition*. The roots of plants cannot feed on the *inside* of a pebble; they can only apply their pumps to its surface and take in so much of what is there exposed as can be dissolved in the moisture which goes to form their sap. Neither can roots travel about in the soil; they grow into certain places, and there they remain.

If an inch away from them there is a mass of rich food, they cannot make use of it—save by sending out new shoots to embrace it—but must remain content with the poorer tract in which they lie. Consequently, the uniform *distribution* of the plant food, its *solubility*, and its *exposure* on the surfaces of the particles of the soil are quite as important as its quantity.

Chemical analysis teaches us none of those things—at least it does not teach them so definitely as we would need to know them to be able to make any practical use of its assistance.

In addition to these, fertile soils must also contain *carbon*, *oxygen*, *nitrogen*, and *hydrogen*, which are called the organic parts of soils, from their great preponderance in vegetables and animals. of which they constitute from 90 to over 99 per cent.

General results of analytical examinations of soils.

1. A due admixture of organic matter is favorable to the fertility of a soil.

2. This organic matter is the more valuable in proportion to the quantity of nitrogen it holds in combination.

3. The mineral part of the soil must contain all those substances which are met with in the ash of the plant, and in such a state of chemical combination that the roots of plants can readily take them up in the requisite proportions.

TABLE, *showing the composition, in 1000 parts, of different kinds of soil.*

CONSTITUENTS.	Fertile without manure.	Fertile with manure.	Very Barren.
Organic matter,	97.	50.	40.
Silica,	648.	833.	758.
Alumina,	57.	51.	101.
Lime,	59.	18.	4.
Magnesia,	8.	8.	1.
Oxide of Iron,	61.	30.	91.
" of Manganese,	1.	3.	trace
Potash,	2.	trace	....
Soda,	4.	....	....
Chlorine,	2.	....	....
Sulphuric Acid,	2.	1.	....
Phosphoric "	4.	2.	....
Carbonic "	40.	4.	....
Loss,	15.	....	5.

NOTE.—The soil designated "fertile without manure" has been cultivated sixty years without manuring, yielding abundant crops. The soil designated "fertile with manure" has been cultivated over forty years, yielding good crops with ordinary manuring; while that designated "very barren" could scarcely be made to yield anything by the greatest manuring and most careful cultivation.

The following is an analysis of three specimens of very fertile soils, made by Sprengel:—

	Soil near Osterbruch.	From the banks of the Weser, near Hoya.	near Weserbe.
Silica, Quartz, Sand, and Silicates	84.510	71.849	83.318
Alumina	6.435	9.350	3.085
Oxides of Iron	2.395	5.410	5.840
Oxides of Manganese	0.450	0.925	0.620
Lime	0.740	0.987	0.720
Magnesia	0.525	0.245	0.120
Potash and Soda extracted by water	0.009	0.007	0.005
Phosphoric Acid	0.120	0.131	0.065
Sulphuric Acid	9.046	0.174	0.025
Chlorine in common Salt	0.006	0.002	0.006
Humic Acid	0.780	1.270	0.800
Insoluble Humus	2.995	.550	4.126
Organic matters containing Nitrogen	0.960	2.000	1.220
Water	0.029	0.100	0.150

The above had remained a long time in pasture, and the second was remarkable for the fattening qualities of its grass when fed to cattle.

The following are arable lands of great fertility:—

	Soil from Moravia.	From Ohio. Soil.	From Ohio. Subsoil.	Soil from Belgium.
Silica and fine Sand	77.209	87.143	94.261	64.517
Alumina	8.514	5.666	1.376	4.810
Oxides of Iron	6.592	2.220	2.336	8.316
Oxide of Manganese	1.520	0.360	1.200	0.800
Lime	0.927	0.564	0.243	Carb. of Lime. 9.403
Magnesia	1.160	0.312	0.310	Carb. of Mag. 10.361
Potash, chiefly combined with Silica	0.140	0.120	0.240	0.100
Soda, ditto	0.640	0.025		0.013
Phosphoric Acid, combined with Lime and Ox. of Iron	0.651	0.060	trace	1.221
Sulphuric Acid and Gypsum	0.011	0.027	0.034	0.009
Chlorine in common Salt	0.010	0.036	trace	0.003
Carbonic Acid united to the Lime	....	0.080	....	....
Humic Acid	0.978	1.304	....	0.447
Insoluble Humus	0.540	1.072	....	....
Organic Substances containing Nitrogen	1.108	1.011	....	....

"Of these soils, the first had been cropped for 160 years successively, without either manure or naked fallow. The second was a virgin soil, and celebrated for its fertility. The third had been unmanured for twelve years, during the last nine of which it had been cropped with beans, barley, potatoes, winter barley and red clover, clover, winter barley, wheat, oats, naked fallow."—*Johnston.*

Depth of soil—its importance.

If 50 be assumed as the value of a given soil when it is six inches deep, its value when of different depths will be as follows:—

If 3 inches deep,	it is	worth	38			If 8 inches deep,	it is	worth	58
4 "	"	"	"	42		9 "	"	"	"	62
5 "	"	"	"	46		10 "	"	"	"	66
6 "	"	"	"	50		11 "	"	"	"	70
7 "	"	"	"	54		12 "	"	"	"	74

Hence each farmer may make an estimate for himself, with regard to every variety of his soil, whether the cost of increasing its depth will equal or exceed its value after the task is performed.

This, of course, supposes that the soil is of the same quality throughout its whole depth, and it refers only to its chemical composition. There are other considerations which make the depth of the soil more important even than the above table will indicate. If a soil is equally rich throughout its whole depth, it would be of more than double value if of double depth; for its ability to withstand drought, and its great capacity to absorb the water of heavy rains (without being made too wet) would made it better, irrespective of the elements of fertility that it might contain. Then again, some soils which are of apparently no value may be made quite fertile by being ploughed a little deeper than has been done.

TABLE, *showing the weight per cubic foot of the different kinds of earth.*

Loose earth or sand	95 lbs.	Clay	135 lbs.
Common soil	124 "	Clay and stones	160 "
Strong soil	127 "	Brick	125 "
Chalk	174 "		

NOTE.—23 cubic feet of sand, 18 cubic feet of earth, or 17 cubic feet of clay, make a ton. Eighteen cubic feet of gravel or earth, before digging, make 27 cubic feet when dug.

As a rough estimate, it may be stated that an acre of ordinary soil weighs 100 tons for every inch of its depth.

EXHAUSTION OF SOILS.

Each crop taken from a field exhausts the soil to the extent of the inorganic or earthy substances that are found in the totality of the crop removed. Unless, therefore, these elements are returned to the soil in some shape it gradually loses its fertility, and finally refuses to produce altogether. Hence the necessity for manuring, irrigating, or *resting* the soil, that it may again, by accumulating these elements, recover its fertility. By returning a crop *in toto* to the soil, by ploughing it in or leaving it to decay and mingle again with it, it accumulates in mass and grows in fertility, not by the substances thus returned to it, but by fertilizing elements gathered in or combined from the atmosphere, by rains and dews descending on it, and by capillary attraction from beneath.

By knowing the composition of the subtracted crops and the added manures, the farmer can keep a debit and credit account with his fields, which will be sufficiently accurate to enable him always to keep his land improving. To enable him to ascertain approximately what his various crops remove from the soil, we introduce the following tables, &c. To ascertain what will replace this subtraction, let him consult the section on manures.

TABLE, *showing the organic substances removed from the soil in* 1000 *lbs. each of the following crops when* perfectly dry.

	Carbon. lbs.	Hydrogen. lbs.	Oxygen. lbs.	Nitrogen. lbs.	Ash. lbs.
Hay	458	50	387	15	90
Red Clover Hay	474	50	378	21	77
Potatoes	440	58	447	15	40
Whoat	461	58	434	23	23
Wheat straw	484	53	389½	3½	70
Oats	507	64	367	22	40
Oat-straw	501	54	390	4	51

Johnston.

NOTE.—Of *all* the vegetable productions which are gathered as food for man or beast in their *dry state*—

Carbon forms nearly *one-half* by weight.

Oxygen rather more than *one-third.*

Hydrogen little more than *five per cent.*

Nitrogen from 1½ to 4 *per cent.*

Earthy matter from 1 to 20 *per cent.*

TABLE, *showing the quantity of inorganic matter removed from the soil in* 1000 *lbs. each of the following crops in their* ordinary state *of dryness.*

		lbs.			lbs.
Wheat	about	20	Beans	about	30
Wheat-straw	"	50	Peas	"	30
Barley	"	30	Pea-straw	"	50
Barley-straw	"	50	Meadow Hay	"	50 to 100
Oats	"	40	Clover Hay	"	90
Oat-straw	"	60	Rye-grass Hay	"	95
Rye	"	20	Potatoes	"	8 to 15
Rye-straw	"	40	Turnips	"	5 to 8
Indian Corn	"	15	Carrots	"	15 to 20
Indian Corn stalk, &c.	"	50			

Johnston.

TABLE, *showing the quantity and kinds of inorganic matter removed from the soil in* 1000 *lbs. each of the following crops.*

	Potash.	Soda.	Lime.	Magnesia.	Alumina.	Silica.	Sulphuric Acid	Phosphoric Acid.	Chlorine.	Oxide of Iron.	Oxide of Manganese.	Total in every 1000 lbs.
Wheat—Grain.........	2.25	2.40	0.96	0.90	0.26	4.00	0.60	0.40	0.10	trace		11.77
" Straw	0.20	0.29	2.40	0.32	0.90	28.70	0.37	1.70	0.30			35.18
Barley—Grain.........	2.78	2.90	1.06	1.80	0.25	11.82	.59	2.16	0.19	trace		23.49
" Straw.........	1.80	0.48	5.54	0.76	1.46	38.50	1.18	1.00	0.70	0.14	0.20	52.42
Oats—Grain...........	1.50	1.32	0.86	0.87	0.14	19.76	0.35	0.70	0.10	0.40		25.80
" Straw...........	8.70	0.02	1.52	0.22	0.06	45 68	0.79	0.12	0.05	0.02	0.02	57.40
Rye—Grain	5.32	*	1.22	0.44	0.24	1.84	0.23	0.46	0.09	0.42	0.34	10.40
" Straw...........	0.32	0.11	1.76	0.12	0.25	22.97	1.70	0.51	0.17			27.93
Field Bean Bean...........	4.15	8.16	1.65	1.58	0.34	1.26	0.89	2.92	0.41			21.36
Field Bean Straw..........	16.56	0.50	8.24	2.09	0.10	2.20	0.34	2.26	0.80	0.07	0.05	31.21
Field Pea Pea............	8.10	7.39	0.68	1.36	0.20	4.10	0.53	1.90	0.38	0.10		24.64
Field Pea Straw..........	2.35		27.30	3.42	0.60	9.96	3.37	2.40	0.04	0.20	0.07	49.71
Potatoes Roots	4.028	2.334	.331	.824	.050	.084	.540	.401	.160	.032		8.284
Potatoes Tops........	8.19	.09	12 97	1.70	.04	4.94	.42	1.97	.50	.02		30.84
Turnips, Roots.......	2.386	1.048	.752	.254	.036	.388	.801	.367	.239	.032		8.303
Turnips, Leaves......	3.23	2.22	6.20	.59	.03	1.28	2.62	.98	.87	.17		18.09
Carrots...............	3.633	.922	657	.384	.039	.137	.270	.514	.070	.033	.080	6.619
Parsnips........	2.079	.702	.468	.270	.024	.162	.192	.100	.178	.005	?	4.180
Rye Grass............	8.81	3.94	7.34	0.90	0 31	27.72	3.63	0.25	0,08			52.86
Red Clover......... ...	19.95	5.29	27.80	3.33	0.14	3.61	4.47	6.57	3.62			74.78
White Clover..........	31.05	5.79	33.48	3.05	1.90	14.73	3.53	6.05	2.11	0.63		91.32
Lucern................	13.40	6.15	48.3	3.48	0.30	3.30	4.04	13.07	3.18	0.30		95 62
Sainfoin....	20.67	4.37	21.95	2.88	0.66	5.00	3.41	9.16	1.57			69.67

Sprengel.

NOTE.—In the foregoing table, the grain, beans, peas, straw, and hay, are estimated after they have been dried in the air; the roots as they have been taken from the field. The potato loses in drying 69 per cent. of water; the turnip 91; the carrot 87; the turnip-leaf 86; the carrot-leaf, parsnip, and parsnip-leaf, each 81; and the cabbage 93.

Besides the *organic elements* present in each of the above crops, and which form about 97 per cent. of the entire dried weight of each, it is not only necessary that all the above

* Included in potash.

inorganic substances should exist in the soil, but that they be also found in a form adapted to the wants of the growing crop.

ANALYSIS OF THE ASH OF THE HOP, *showing the elements it removes from the soil.*

In 100 parts there are of

	Vine & Blossom.	Blossom.		Vine & Blossom.	Blossom.
Silica	13.24	21.05	Magnesia	4.09	5.77
Chloride of Sodium	7.73		Sulphuric Acid	4.63	5.41
" Potassium	3.77		Phosphoric "	6.34	9.08
Soda	0.13		Phosphate of Iron	3.79	7.45
Potash	21.49	25.18	Chloride of Potassium		1.67
Lime	34.79	15.98	Alumina		a trace

The following tables, extracted from Waring's Elements of Agriculture, will be found convenient for ordinary computations :—

Amount of Inorganic Matter removed from the soil by ten bushels of grain, &c., and by the straw, &c., required in their production—estimated in pounds:

	Wheat.	1200 lbs. Wheat Straw.	Rye.	1620 lbs. Rye Straw.
Potash	2.86	8.97	2.51	11.34
Soda	1.04	.12	1.33	.20
Lime	.34	4.84	.56	5.91
Magnesia	1.46	2.76	1.18	1.58
Oxide of Iron	.08	.94	.15	.88
Sulphuric Acid	.03	4.20	.11	.05
Phosphoric Acid	6.01	2.22	5.64	2.49
Chlorine		.79		.30
Silica	.14	47.16	.05	42.25
Pounds carried off	12	72	11½	66

	Corn.	1620 lbs. Corn Stalks.	Oats.	700 lbs. Oat Straw.
Potash	2.78	6.84	1.69	12.08
Soda		19.83		
Lime	.12	6.02	.39	3.39
Magnesia	1.52	4.74	.64	1.59
Oxide of Iron		.57	.02	.78
Sulphuric Acid		.36	.66	1.41
Phosphoric Acid	4.52	12.15	2.80	1.07
Chlorine		1.33	.02	1.36
Silica	.06	19.16	.18	20.32
Pounds carried off	9	71	6½	42

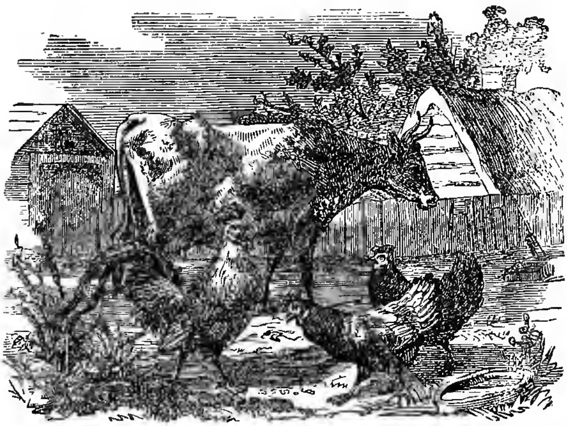
	Buck Wheat.	Barley.	660 bbls. Barley Straw.	2000 lbs. Flax.
Potash	1.01	1.90	2 57	11.78
Soda	2.13	1.18	.23	11.82
Lime	.78	.96	3.88	11.85
Magnesia	1.20	1.00	1.31	9.38
Oxide of Iron	.14	.20	.90	7.32
Sulphuric Acid	.25	.01	.66	3.19
Phosphoric Acid	5.40	5 35	1.25	13.05
Chlorine		.01	.40	2.90
Silica	.09	3.90	28.80	25.71
Pounds carried off	11	14	40	100

	Beans.	1120 lbs. Bean Straw.	Field Peas.	1366 lbs. Pea Straw.
Potash	5.54	36.28	5.90	3.78
Soda	1.83	1.09	1.40	
Lime	98.98	13.60	.81	43.93
Magnesin	.28	4.55	1.30	5.50
Oxide of Iron	.10	.20	.15	1.40
Sulphuric Acid	.16	64	.64	5.43
Phosphoric Acid	7.80	5.00	5.50	3.86
Chlorine	.13	1.74	.23	.08
Silica	.18	4.90	.7	16.02
Pounds carried off	17	68	16	80

	1 Ton Turnips.	635 lbs. Turnip Tops.	1 Ton Potatoes.	2000 lbs. Red Clover.
Potash	7.14	4.34	27.82	31.41
Soda	.86	.84	.93	8.34
Lime	2.31	3.61	1.03	43.77
Magnesia	.91	.48	2.63	5.25
Oxide of Iron	.23	.13	.26	.23
Sulphuric Acid	2.30	1.81	6.81	7.05
Phosphoric Acid	1.29	1.31	6.25	10.28
Chlorine	.61	2.35	2.13	5.86
Silica	1.36	.13	2.14	5.81
Pounds carried off	17	15	50	118

	2000 lbs. Meadow Hay.	2000 lbs. Cabbage. Water 9-10
Potash	18.11	5.25
Soda	1.35	9.20
Lime	22.95	9.45
Magnesia	6.75	2.70
Oxide of Iron	1.69	.25
Sulphuric Acid	2.70	9.60
Phosphoric Acid	5.97	5.60
Chlorine	2.59	2.60
Silica	37.89	.35
Pounds carried off	100	45

MANURES.



In order to restore to the soil the matters which have been taken from it by the removal of its produce, as well as to add to its power to produce—to make it richer, or to keep it from growing poorer—we make use of what are known as *manures.*

This term is a very comprehensive one, and is taken to mean all substances—whatever their character or origin—which will have the effect of causing a larger growth of vegetation.

Manures may be either *mechanical* or *chemical* in their mode of action, or they may partake of both of these characters. For instance, barn-yard manure is both mechanical and chemical in its effect.

By reason of its bulk and its coarseness it loosens the soil and makes it more porous when mixed with it; when it is used as a top-dressing it shades the ground, and protects it in a measure against the effect of frost and of too great heat; being a very active absorbent of moisture, it modifies the effect of drought; its decomposition produces heat, and raises the temperature of the soil.

All of these are *mechanical* effects.

On the other hand, it affords to the roots of plants substances which enter directly into their structures, as chemical constituents; it also yields various acids, alkalies, and salts which enter into combination with the constituent parts of the soil, and—in one way or another—make them more available as plant food.

These are *chemical* effects.

The use of Manures.

In the use of manures the farmer should be guided not only by the effect that will be produced on the immediate crop—although this is, of course, the first consideration—but quite as much by the condition in which the soil will be left for the production of future crops. Unless he does this he may find that, while he has reaped a temporary benefit, he has inflicted a lasting injury on his fields.

It will be remembered that in our account of the soil it was shown that the amount of mineral plant food that is actually present in the soil in an available form is extremely limited. In a state of nature, our fields would produce only such crops as could be fed by the small amount of this plant food which is rendered available from year to year, and there would be no diminution of production. On the contrary, the decay of the crop of one year would probably add to the supply available for the next year. *The removal of the crop by man, not the production of a crop which on decay returns its elements to the soil*, is what impoverishes—is what makes the use of manure vitally necessary on all but virgin lands.

The larger the crop—provided it *decays on the land*—the more the fertility of the soil is increased.

The larger the crop—provided it is *removed from the land*—the more the fertility of the soil is diminished.

If the crop is made larger by the use of manure, and is removed from the land, the manure has caused a larger amount of mineral plant food to be taken away. But if the manure itself contains the full equivalent of what enters into the crop, and so makes up for its drain upon the soil, there will be no impoverishment. If, on the other hand, the manure does not contain the equivalent of the ash-constituents of the crop, but has only stimulated it to take an extra supply from the soil, the injury is obvious.

In some cases, a soil that will produce 10 bushels of wheat without manure will produce 25 bushels if dressed with 100 lbs. of sulphate of ammonia. The extra 15 bushels contain about 18 lbs. of mineral matter more, which was supplied by the manure, and this is equal to one and a half year's supply for the natural crop of the land. The effect of this sort of farming is that the soil is made to produce more than it can afford to in one year, and has its supply of mineral plant food exhausted to the detriment of its future productiveness.

Twenty years ago, the wheat lands of Delaware, which had been producing very small crops, were made, by the use of very small doses of Peruvian guano, to double, triple, even quadruple their yield. The farmers were immensely elated. They had found a sort of philosopher's stone, and a few years would make their fortune. Alas for their hopes —a very few years demonstrated the fact that the guano had been a curse rather than a blessing. Their lands were poorer than ever, and even largely increased doses of the specific were powerless to bring them up even to their old standard.

Had the wheat and straw been consumed on the farm, and all of their mineral constituents returned to the soil, the guano would have been a means of great permanent improvement.

Or, had the same increase of production been effected by the use of a manure containing the full equivalent of what the crop was to take from the soil, the impoverishment of the land would have been prevented.

The foregoing is intended to convey the fundamental ideas which we should bear in mind in deciding what manures we are to use, and in what quantity. It is quite impossible to establish any set of rules which shall be an exact guide for all cases, but the following are always a *safe* guide: —

1. *Apply in the manure the full quantity of the different ash ingredients of the crops that will be produced before manure will be applied again.*

2. *Procure from abroad manure containing the full quantity of the different ash ingredients of all produce sold from the farm, and allow none to be wasted at home.*

A close adherence to these two rules, accompanied by good cultivation, and the draining of such land as needs draining, will make any farmer rich who exercises ordinary judgment and prudence in the management of his affairs.

To speak with scientific accuracy, it is not necessary to return quite *all* that the crops take away.

The processes by which soils were originally formed being still in operation, there is a constant fresh development of plant-food in the ground, and this will, in greater or less degree, compensate for the loss by the removal of crops.

Practically, however, it is best to place this development of fresh matter to the account of improvement, and, by making up the full amount of all removals, to make sure that the land is constantly growing better instead of worse.

As want of space forbids a more full discussion of the established theories concerning the use of manure, the attention of the reader is called to the following:—

Classification and description of manures.

Manures naturally divide themselves into such as are of mineral, of vegetable, and of animal origin.

Mineral manures are such as originate from various mineral substances, such as lime, which is the product of limestone, marble, chalk, or marl, after the carbonic acid has been expelled by an intense heat; marls, which are composed of carbonate of lime, mixed with clay, sand, or loam; shell sand, calcareous sand, green sand marl, gypsum, phosphate of lime, salt, and salts of various kinds, &c.

Vegetable manures are such as are produced from decomposed vegetable matters, which also contain some of the inorganic or mineral substances.

Animal manures consist chiefly of the flesh, blood, bones, horns, and hair of sea and land animals, and of the solid and liquid excrements of land animals and birds, and also contain some of the inorganic or mineral matters.

Analysis of Fish Guano.

Water expelled by 212° heat	8.06	Sulphate of Magnesia	0.71
Sand	0.33	" Potash	2.05
Oil	2.40	" Soda	2.42
Organic Matter	50.72	Chloride of Sodium	1.12
Super-Phosphate of Lime	9.85	Sulphate of Ammonia	2.72
Sulphate of Lime, Hydrated	19.62		

Dr. Apjohn.

Analysis of Peruvian Guano.

In every 100 parts there are of

Organic Matter, containing Nitrogen, including Urate of Ammonia, and capable of affording from 8 to 17 per cent. of Ammonia, by slow change in the soil	50.
Water	11.
Phosphate of Lime	25.
Ammonia, Phosphate of Magnesia, Phosphate of Ammonia and Oxalate of Ammonia, containing from 4 to 9 per cent. of Ammonia	13.
Silicious matter from the crops of birds	1.

Dr. Ure.

Another analysis.

Water	13.09
Organic Matter, containing Ammonia	53.17
Common Salt and Sulphate of Soda	4.63
Carbonate of Lime	4.18
Phosphate of Lime and Magnesia	23.54
Silicious Matter or Sand	1.39

Johnston.

Professor S. W. Johnson publishes the following table:—

Analysis of Peruvian Guano.

	I.		II.		III.		IV.
Water } Organic Matter	66.32	65.18	12.63	12.70	68.00	68.70	59.46
Organic Matter			52.27	51.46			
Ammonia, potential	5.82	5.95	16.03	15.98	17.86	18.85	16.32
" actual	8.93	9.08					
Phosphoric Acid soluble in water	4.69	3.64	15.19	14.08			
Phosphoric Acid insoluble in water	10.05	10.50					
Sand, &c., insoluble in acids	1.69	1.52	2.45	2.66			
Phosphate of Lime, equivalent to total Phosphoric Acid. } Av.	21.28		31.69				

Analysis of Bolivian Guano.

Water	6.91
Organic Matter containing Ammonia	55.52
Common Salt and Sulphate of Soda	6.31
Carbonate of Lime	3.87
Phosphate of Lime and Magnesia	25.68
Silicious Matter or Sand	1.71

Johnston.

NOTE.—The guano of the *Lobos Islands* is from 25 to 33 per cent. less valuable than the above.

How to select a good article of guano.

1. The drier the better—there is less water to pay for and transport.

2. The lighter the color the better—it is the less completely dissolved.

3. If it has not a strong ammoniacal smell, it ought to give off such a smell when a spoonful of it is mixed with a spoonful of slaked lime in a wine-glass.

4. When put into a tumbler with water and stirred well, and the water and fine matter poured off, it ought to leave but little sand or stones.

5. When heated to redness over a fire or bright flame, until the animal matter is burned away, the ash should nearly all dissolve in dilute muriatic acid.

6. In looking at the printed analysis (which almost all dealers furnish), see that the per cent. of water is small; that the organic matter containing ammonia approaches to 50 or 60 per cent.; that the phosphates do not exceed 20 per cent., and the common salt and sulphate of soda do not exceed 5 or 6 per cent.—*Johnston.*

How to Apply Guano.—From 200 to 500 lbs. per acre is a proper dressing, the largest quantity being required for the more sterile soils. Mix it thoroughly for a few days with five times its bulk of vegetable mould or loam and some charcoal or gypsum, after breaking the lumps and sifting in alternate layers. Avoid the use of ashes or lime, as they tend to expel the ammonia. Keep it under cover, beyond the reach of water or rains, until used. It may then be scattered broadcast upon meadows or grain, or placed near the seeds or young plants in the hill.

Analysis of bone (crushed) manure.

In 100 parts, there are of

Lime	55.5	Carbonate of Lime	3.75
Phosphate of Magnesia	2.	Fluoride of Calcium	3.
Soda and Common Salt	2.5	Gelatine (the substance of *horn*)	33.25

TABLE, *showing the comparative value of animal manures, with farm-yard manure as the standard.*

100 lbs. farm-yard manure is equal to

125	lbs.	solid	excrements	of the	cow.	3	lbs.	Dry Flesh.
73	"	"	"	"	horse.	5	"	Pigeon's Dung.
91	"	liquid	"	"	cow.	15	"	Liquid Blood.
16	"	"	"	"	horse.	4	"	Dry Blood.
98	"	mixed	"	"	cow.	3	"	Feathers.
54	"	"	"	"	horse.	3	"	Cow Hair.
36	"	"	"	"	sheep.	3	"	Horn Shavings.
64	"	"	"	"	pig.	3½	"	Dry Woollen Rags.

Johnston.

NOTE.—The most powerful substances in the above table, viz., dry woollen rags, horn shavings, cow hair, feathers, &c., hold little or no water, and contain the fertilizing elements of the others in very *compact forms.* They show less *immediate* sensible effect upon the crop than the others, because, being so dry and compact, they are long decomposing, but continue to evolve fertilizing matter long after the softer and more fluid manures have spent their force.

Decomposed vegetables as manure.

The *characteristic distinction* between animal and vegetable manures lies in the fact of the former containing a much larger proportion of nitrogen than the latter.

There are two grounds upon which the relative values of different vegetable substances as manures may be estimated. *First*, from the quantity and kind of *inorganic matter* they contain. *Second*, from the proportion of *nitrogen* present in each.

TABLE, *showing the relative values of decomposed vegetables as manures, from the* inorganic matter *they contain.*

								Inorganic Matter. lbs. lbs.
1	ton	Wheat Straw	made into	manure	returns	to the soil		70 to 360
1	"	Oat	"	"	"	"		100 to 180
1	"	Hay	"	"	"	"		100 to 200
1	"	Barley	"	"	"	"		100 to 120
1	"	Pea	"	"	"	"		100 to 110
1	"	Bean	"	"	"	"		100 to 130
1	"	Rye	"	"	"	"		50 to 100
1	"	Dry Potato-tops	"	"	"	"		400
1	"	Dry Turnip-tops	"	"	"	"		370
1	"	Rape Cake	"	"	"	"		120
1	"	Malt Dust	"	"	"	"		180
1	"	Dried Seaweed	"	"	"	"		560

Johnston.

TABLE, *showing the relative values of decomposed vegetables as manures, from the* nitrogen *they contain.*

100 lbs. of farm-yard manure is equal to

130 lbs.	Wheat Straw	Manure.		80 lbs	Fresh Seaweed	Manure.
150 "	Oat "	"		20 "	Dried "	"
180 "	Barley "	"		26 "	Bran of Wheat or Corn	"
85 "	B'kwh't "	"		13 "	Malt Dust	"
45 "	Pea "	"		8 "	Rape Cake	"
50 "	Wheat Chaff	"		250 "	Pine Sawdust	"
80 "	Green Grass	"		180 "	Oak "	"
75 "	Potato Tops	"		25 "	Coal Soot	"

Boussingault.

Notes.—The *immediate* effect of vegetable manures in hastening the growth of plants is dependent, in a great measure, upon the quantity of nitrogen they contain, which is given off chiefly in the form of ammonia during their decay in the soil, and may be nearly exhausted in a single season.

Their *permanent* effect and value is to be estimated by the quantity and quality of inorganic matter they contain, or ash they leave when burned, and may not be exhausted for several years.

Besides inorganic matters and nitrogen, there are other ingredients in vegetable manures which are necessary to the sustenance and growth of plants.

Each of the elements present in decayed or decaying plants is capable either of ministering to, or preparing food for such as are still alive.

All refuse vegetable or animal matter on a farm, such as straw, leaves, vegetable tops, chips, sawdust, ashes, dead animals, bones, horns, hoofs, entrails, &c., &c., should be carefully saved and composted, or otherwise made into manure for the use of the farm.

Analysis of a manure heap in the condition usually applied to the field.

Fresh.		Dried at 212°.	
Water	64.96	Carbon	37.40
Organic Matter	24.71	Hydrogen	5.27
Inorganic Salts	10.33	Oxygen	25.52
		Nitrogen	1.76
		Ashes (inorganic matter)	30.05

Inorganic matters.

Soluble in Muriatic Acid.		Soluble in Water.	
Silica	27.01	Potash	3.22
Phosphate of Lime	7.11	Soda	2.73
" Magnesia	2.26	Lime	0.34
" Iron	4.68	Magnesia	0.26
Carbonate of Lime	9.34	Sulphuric Acid	3.27
" Magnesia	1.63	Chlorine	3.15
Sand	30.99	Silica	0.04
Carbon	.83		
Alkali and loss	3.14		13.01
			86.99
	86.99	*Richardson.*	100.00

Analysis of other specimens of fresh farm-yard manures.

	Farm yard Manure From Kent.	Farm-yard Manure From Surrey.
Per centage of Ash	9.2	9.6
Silica	70.79	71.32
Potash	3.32	5.14
Soda	0.92	1.68
Lime	6.90	12.32
Magnesia	0.56	0.82
Common Salt	1.43	1.22
Phosphate of Iron	2.04	2.03
" Alumina	1.53	2.54
Sulphuric Acid	1.89	1.57
Phosphoric Acid	1.58	1.27
Manganese	trace	....
	90.96	99.91

Allen & Greenhill.

Composition of fresh farm-yard manure (composed of horse, pig, and cow dung, about fourteen days old). Analysis made November 3, 1854, by Dr. Augustus Voelcker, Professor of Chemistry in the Royal Agricultural College, Cirencester, England :—

Water		66.17
* Soluble organic matter		2.48
Soluble inorganic matter (ash)—		
Soluble silica (silicic acid)	.237	
Phosphate of lime	.299	
Lime	.066	
Magnesia	.011	
Potash	.573	
Chloride of sodium	.030	
Carbonic acid and loss	.218	
		1.54
† Insoluble organic matter		25.76
Insoluble inorganic matter (ash)—		
Soluble silica } silicic acid	.967	
Insoluble silica } silicic acid	.561	
Oxide of iron, alumina, with phosphates.	.596	
(Containing phosphoric acid, .178)		
(Equal to bone earth, .386)		
Lime	1.120	
Magnesia	.143	
Potash	.099	
Soda	.019	
Sulphuric acid	.061	
Carbonic acid and loss	.484	
		4.05
		100.00

* Containing nitrogen	.149		
Equal to ammonia		.181	
† Containing nitrogen	.494		
Equal to ammonia		.599	
The whole manure contains ammonia in a free state			.034
" " " " in the form of salts			.088

According to this analysis one ton (2000 lbs.) farm-yard manure contains—

Soluble silica (silicic acid)	24	lbs.
Ammonia (actual or potential)	$15\frac{3}{5}$	"
Phosphate of lime	$13\frac{7}{10}$	"
Lime	$23\frac{7}{10}$	"
Magnesia	$3\frac{1}{10}$	"
Potash	$13\frac{1}{2}$	"
Soda	$1\frac{2}{5}$	"
Common salt	$\frac{6}{10}$	"
Sulphuric acid	$2\frac{1}{3}$	"
Water	$1323\frac{2}{5}$	"
Woody fibre, &c	579	"

Of course no two samples of farm-yard manure are exactly of the same composition. That analyzed by Dr. Voelcker was selected with much care, as representing a fair average.

GREEN SAND MARL (OF NEW JERSEY).

Protoxide of iron	15.5
Alumina	6.9
Lime	5.3
Magnesia	1.6
Potash	4.8
Soluble silica	32.4
Insoluble silica and sand	19.8
Sulphuric acid	.6
Phosphoric acid	1.3
Water	8.0
Carbonic acid, &c	3.8
	100.0

This is an average of three analyses copied from Prof. Geo. H. Cook's Report of the Geology of New Jersey. According to this estimate one ton (2000 lbs.) of green sand marl contains—

Lime.............	106 lbs.	Soluble silicic acid.	648 lbs.
Magnesia........	32 "	Sulphuric acid.....	12 "
Potash..........	96 "	Phosphoric acid*...	26 "

To give a better idea of the formation and composition of stable manure, the following is copied from "Waring's Elements of Agriculture":—

"DIGESTION AND ITS PRODUCTS.

"Let us suppose that we have a full-grown ox, which is not increasing in any of his parts, but only consumes food to keep up his respiration, and to supply the natural wastes of his body. To this ox we will feed a ton of hay which contains organic matter, with and without nitrogen, and soluble and insoluble earthy substances. Now let us try to follow the food through its changes in the animal, and see what becomes of it. Liebig compares the consumption of food by animals to the imperfect burning of wood in a stove, where a portion of the fuel is resolved into gases and ashes (that is, it is completely burned), and another portion, which is not thoroughly burned, passes off as *soot.* In the animal action in question, the food undergoes changes which are similar to this burning of wood. A part of the food is *digested* and taken up by the blood,

* Equal to phosphate of lime 56⅓ lbs.

while another portion remains undigested, and passes the bowels as solid dung—corresponding to the soot of combustion. This part of the dung, then, we see is merely so much of the food as passes through the system without being materially changed. Its nature is easily understood. It contains organic and mineral matters in nearly the condition in which they existed in the hay. They have been rendered finer and softer, but their *chemical* character (their composition) is not materially altered. The dung also contains small quantities of nitrogenous matter, which has *leaked out*, as it were, from the stomach and intestines. The digested food, however, undergoes further changes which affect its character, and it escapes from the body in three ways—*i. e.*, through the lungs and skin, through the bladder, and through the bowels. It will be recollected from the first section of this book, p. 20, that the carbon in the blood of animals unites with the oxygen of the air drawn into the lungs, and is thrown off in the breath as carbonic acid. The hydrogen and oxygen unite to form a part of the water which constitutes the moisture of the breath.

"That portion of the atmospheric part of the hay which has been taken up by the blood of the ox, and which does not contain nitrogen, is emitted through the lungs. It consists, as will be recollected, of carbon, hydrogen, and oxygen, and these assume, in respiration, the form of carbonic acid and water.

"The atmospheric matter of the digested hay, in the blood, which does contain nitrogen, goes to the *bladder*, where it assumes the form of urea—a constituent of urine or liquid manure.

"We have now disposed of the imperfectly digested food (the dung), and of the *atmospheric* matter which was taken up by the blood. All that remains to be examined is the earthy matter in the blood, which would have become *ashes* if the hay had been burned. The readily *soluble* part of this earthy matter passes into the bladder, and forms the *earthy parts of urine.* The more *insoluble* part passes the bowels, in connection with the dung.

"If any of the food taken up by the blood is not returned as above stated, it goes to form fat, muscle, hair, bones, or some other part of the animal; and as he is not growing (not increasing in weight), an equivalent amount of the body of the animal goes to the manure to take the place of the part retained.*

"We now have our subject in a form to be readily understood. We learn that when food is given to animals it is not *put out of existence*, but is merely *changed in form;* and that in the impurities of the breath we have a large portion of those parts of the food which plants obtain from air and from water; while the solid and liquid excrements

* This account of digestion is not, perhaps, strictly accurate in a physiological point of view, but it is sufficiently so to give an elementary understanding of the character of excrement as manure.

contain all that was taken by the plants from the soil and from manures.

"The Solid Dung contains the undigested parts of the food, the more *insoluble* parts of the ash, and the nitrogenous matters which have *escaped* from the digestive organs.

"The Liquid Manure contains the nitrogenous parts of the digested food, and the *soluble* parts of the ash.

"The Breath contains those parts of the fully digested food which contain carbon, hydrogen, and oxygen, but *no nitrogen*, or at least a very inconsiderable quantity of it."

LIQUID MANURE.

We believe there is no system of enriching the land for small gardens, with a view to perfection of crops, so truly economical and so easily available as that of using liquid manure. We occasionally hear of a gardener, or an amateur grower of some special plant or crop, that has practised enriching with liquids, but it is only occasionally; yet the result of every record is in its favor, and a searching inquiry into any extra production of fruit, flower, or plant almost invariably gives watering with liquid manure as the cause. There is in almost every family a waste of liquids, which usually go into the sewer or drain, or possibly upon the road, where they are of no avail, but if saved by being conducted to a tank, would enrich the entire garden spot of vegetables, small fruits, furnish stimulus to the rose and other flower borders, and keep the grass-plot green and fresh even in the hottest and driest weather of midsummer. The use of a little plaster (gypsum) occasionally, thrown in and around the tank, would always keep it sweet and clean. By the use and practice of liquid manuring no delay need ever occur in planting-time because of the manure not being on hand, or not being in a sufficiently rotted condition; but planting could proceed, and the application of manure be made at leisure.—*Horticulturist.*

Value of liquid manures.

The urine voided from a cow during one year contains 900 lbs. solid matter, and compared with Peruvian guano at $50 per ton is worth $20. It will manure 1¼ acres of land, and is more valuable than its dung, in the ratio, by bulk, of 7 to 6, and in intrinsic value as 2 to 1.—*Dana.*

The Urine of the	Cow	contains of water	92.6	per cent.
" "	Horse	" "	94.	"
" "	Sheep	" "	96.	"
" "	Hog	" "	92.6	"
" "	Human	" "	93.3	"

The remainder is composed of salts and rich food for vegetables.—*Sprengel.*

Poudrette and Urate.

Poudrette is the name given to the human excrement after being mixed with charcoal dust or charred peat, to disinfect it of its effluvia, and when dried becomes convenient for use or transportation.

Urate is the name given to urine after mixing with it ⅙ or $\frac{1}{7}$ of its weight of ground gypsum, and allowing it to stand several days. The urine combines with a portion of the ammonia, after which the liquid is poured off and the remainder dried.—*Allen.*

Analysis of night soil.

The excrement of a healthy man yielded in 1000 parts—

Water	733.	Mucilage, fat, and animal matter	167.
Albumen	9.	Saline matters	12.
Bile	9.	Undecomposed food	70.

Man's urine yielded in 1000 parts—

Water	933.	Phosphate of ammonia	1.6
Urea	30.1	" soda	2.9
Uric acid	1.	Sal ammoniac	1.5
Free acetic acid, lactate of ammonia, and animal matter	17.1	Common salt	4.5
Mucus of the bladder	3.3	Phosphate of lime and magnesia, with a trace of silica and fluoride of calcium	1.1
Sulphate of potash	3.7		
" soda	3.2		1000.

Berzelius.

Urea is a solid product of urine, and gives in 100 parts—

Carbon	19.99	Hydrogen	6.65
Oxygen	26.63	Nitrogen	46 65

Prout.

THE DRY EARTH SYSTEM.

It has long been a difficult problem to decide in what way to dispose of human excrement so as to make use of its invaluable ingredients as manure, and, at the same time, to avoid the offensiveness which attends its management in China and Japan, and in all countries where it is habitually applied to the soil.

This problem has at last found a satisfactory solution in the invention of the Rev. Henry Moule, Vicar of Fordington, Dorsetshire, England.

This invention is based on the power of common soil, when dried and sifted, to absorb, not only the moisture of human excrement, but its odor as well.

This power of absorbing odors is due to both the clay and the decomposed organic matter in the soil. It was first discovered, or at least first satisfactorily explained, by Prof. Way, chemist to the Royal Agricultural Society of England, whose interesting experiments on the subject are detailed in the Society's Journal.

It is odd that this easy means of arresting the offensive exhalations of human excrement was not long ago generally adopted. We have a practical illustration of this use of earth in the case of animals of the feline race, whose dejections are extremely offensive. They turn and carefully cover these with earth. In the adhesion of the world to many of the tenets of the Mosaic law, it is strange that we have overlooked the sound advice given in the 12th and

13th verses of the xxiii. chap. of Deut., where we read, "Thou shalt have a place also without the camp whither thou shalt go forth abroad; and thou shalt have a paddle upon thy weapon; and it shall be when thou shalt ease thyself abroad, thou shalt dig therewith and shalt turn back and cover that which cometh from thee."

Mr. Moule's invention is susceptible of many modifications. The apparatus which he has devised, and which is coming into quite general use in England, especially in detached country houses and cottages, where there is no supply of water for water-closets, consists of a hopper-shaped reservoir behind and above the ordinary water-closet seatf or holding the supply of dry earth,—this forms a back; a water-tight vessel or vault under the seat; and a mechanical arrangement for measuring out the proper quantity of earth (about a pint and a half) and throwing it forward upon the evacuation, which it entirely covers while it absorbs all the moisture.

This apparatus is simple, inexpensive, not liable to get out of order, and cannot be obstructed by frost.

A modification of the same, still more simple, cheap, and equally effective, though much less convenient, consists of a tub or box (filled with dry earth) at the side of the seat, and a common tin scoop with which to throw the earth upon the deposit. This plan is being generally adopted in the prisons and workhouses of England and the British colonies.

In fact, any vessel containing two inches or more of sifted, dry earth, and a second vessel containing a supply of earth and a scoop or cup with which to handle it, will answer a good purpose on emergency, and will enable the poorest person not merely to mitigate but to absolutely overcome the most offensive accompaniment of sickness.*

While this invention offers relief from untold misery and annoyance to all who cannot conveniently establish water-closets in their houses, its agricultural importance makes it especially interesting to farmers.

It is a fact too well known to need discussion in our limited space, that of all manures none are at once so powerful and so well adapted to the growth of all crops as "night-soil," or human excrement, though its highly offensive character has generally prevented its use, and has associated with it an idea of degradation. In most parts of the country farm-hands would leave their places rather than to have anything to do with the stuff; and where it is commonly used, it is made a nuisance to wide neighborhoods.

By the aid of the dry earth system every real and fancied objection to its use is done away with. The mixed earth and "soil," when dried and pulverized, are absolutely without other smell than that of freshly turned earth; and, although every atom of fertilizing matter has been retained in a most available form, there is nothing by which, from either appearance or odor, its character could be suspected.

The most remarkable part of the whole matter is, that

* For more particular information on this subject, the reader is referred to a pamphlet entitled "Earth Closets, how to make and how to use them," published by the N. Y. Tribune Association.

when the ordure is once decomposed and (by sifting) intimately mixed with the earth, it has the same quality as any other decomposed organic matter, *i. e.*, it acts as a deodorizer. Consequently, the same earth (by drying and sifting) may be used over and over again, always (at least up to the eighth or tenth time of using) being inodorous and as good a disinfectant as fresh earth; therefore the quantity of earth which it is necessary to prepare and store need not be very large, and it may be made so rich as to be equal to Peruvian guano in its effect on vegetation.

In short, in the opinion of the writer, who has had personal experience in the use of the apparatus, in "sickness and in health," the adoption of the dry earth system is "the coming reform."

TABLE, *showing the comparative increase of corn by different fertilizers.*

No. experiment	QUANTITY OF FERTILIZER.	Yield per acre in bushels.	Increase in bush.	Cost of manure.	Increase of corn for each dollar's worth of manure.	
				$	bus	qrts.
1	No Manure	28				
2	500 lbs Superphosphate of Lime	46	18	12 50	1	14
3	690 " Guano	50½	22½	19 00	1	6
4	300 " Superphosphate Lime & 640 lbs. Guano	58	30	25 10	1	6¾
5	320 " Guano and 640 lbs. dissolved Bones	51	23	18 40	1	8
6	1040 " Guano & 400 lbs. Superphosphate Lime	74¾	46¾	38 60	1	6¾
7	16 loads Stable Manure	35½	7½	16 00		15
8	32 " "	42¾	14¾	32 00		14¾
9	16 " " & 200 bus. leached Ashes	44	8	12 00*		22¾
10	16 " " & 640 lbs. Super P. Lime	49½	14½	17 80*		28
11	32 " " & 320 lbs Guano & 1320 lbs Superphosphate Lime	60	17¼	16 80*	1	¾
12	Hog manure from 108 bus. corn	43	15	16 20		30

* Only the increase over the experiments 7 and 8 with stable manure alone.

All tables showing the comparative effect of different manures are of very problematical value. There are so many circumstances and conditions of soil, climate, exposure, moisture, previous treatment of the land, &c., &c.—all of which affect, more or less strongly, the amount of the crop—that it is never possible (in the light of our still imperfect knowledge concerning the growth of plants, and their relations to the soil) to decide how far any increase or decrease may be due to the manure used, and how far to other causes.

TABLE, *showing the effect produced upon the quantity of the crop by equal quantities of different manures applied to the same soil, sown with an equal quantity of the same seed.*

Manure applied.	Return in bushels from each bushel of seed. Wheat.	Barley.	Oats.	Rye.
Blood	14	16	12½	14
Night-soil	..	13	14½	13½
Sheep-dung	12	16	14	13
Horse-dung	10	13	14	11
Pigeon-dung	..	10	12	9
Cow-dung	7	11	16	9
Vegetable manure	3	7	13	6
Without manure	..	4	5	4

Moisture absorbed by different manures.

1000 parts horse-dung, dried in a temperature of 100° Fahrenheit, absorbed by exposure to the air at a temperature of 62° Fahrenheit, moisture, parts 145

1000 parts cow-dung, under same circumstances, " 130

1000 parts	pig-dung, under the same circumstances,			parts	120
"	sheep-dung,	"	"	"	81
"	pigeon-dung,	"	"	"	50
"	rich alluvial soil,	"	"	"	14
"	fresh tanners' bark,	"	"	"	115
"	putrified "	"	"	"	145
"	refuse marine salt,	"	"	"	49½
"	soot,	"	"	"	36
"	burnt clay,	"	"	"	29
"	coal ashes,	"	"	"	14
"	lime,	"	"	"	11
"	sediment from salt-pans,		"	"	10
"	crushed rock-salt,		"	"	10
"	gypsum,		"	"	9
"	chalk,		"	"	4

TABLE, *showing the number of loads of manure and the number of heaps to each load required to each acre, the heaps at given distances apart.*

Distance of heaps apart, in yards.	NUMBER OF HEAPS IN A LOAD.									
	1	2	3	4	5	6	7	8	9	10
3	538	269	179	134	108	89½	77	67	60	54
3½	395	168	132	99	79	66	56½	49½	44	39½
4	203	151	101	75½	60½	50½	43¼	37¾	33½	30¼
4½	239	120	79½	60	47¾	39¾	34¼	30	26½	24
5	194	97	64½	48½	38¾	32¼	27¾	24¼	21½	19¼
5½	160	80	53½	40	32	26¾	22¾	20	17¾	16
6	131	67	44¾	33½	27	22½	19¼	16¾	15	13½
6½	115	57½	38¼	28¾	23	19	16¼	14¼	12¾	11½
7	99	49½	33	24¾	19¾	16½	14	12¼	11	10
7½	86	43	28¾	21½	17¼	14¼	12¼	10¾	9½	8½
8	75½	37¾	25¼	19	15¾	12½	10¾	9½	8½	7½
8½	67	33½	22¼	16¾	13½	11¼	9½	8½	7½	6¾
9	60	30	20	15	12	10	8½	7¾	6¾	6
9½	53½	26¾	18	13½	10¾	9	7¾	6¾	6	5¼
10	48½	24¼	16¼	12	9¾	8	7	6	5½	4¾

Explanation.—In the left hand column are placed the distances of the rows and the heaps in each row (*i. e.*, the distances between the heaps in each direction), and at the top of the columns will be noticed the number of heaps intended to be made of each load; the point where the two meet gives the number of loads per acre which will be required for that purpose.

Example 1.—Required the number of loads necessary to manure an acre, dividing each load into six heaps, and placing them $4\frac{1}{2}$ yards apart?

Solution.—In the left hand column find $4\frac{1}{2}$ (the distance of the heaps apart), and opposite it to the right, under 6 (the number of heaps in each load), will be found $39\frac{3}{4}$. *Ans.*

Example 2.—A farmer has a field containing $5\frac{1}{2}$ acres, over which he wishes to spread 82 loads of manure. Now, 82 divided by $5\frac{1}{2}$ gives 15 loads per acre, and by referring to the table it will be seen that the desired object can be attained by making 4 heaps of each load, and placing them 9 yards apart, or by 9 heaps at 6 yards apart, as may be thought most advisable.

Notes.—A cubic foot of half-rotten stable manure will weigh 56 lbs.; if coarse or dry, 48 lbs.

A load of manure is about 36 cubic feet, and of the first quality will weigh 2016 lbs.; of the second, 1728 lbs.

Eight loads of the first kind spread over an acre will give

108 lbs. to each square rod, and about $3\frac{1}{2}$ lbs. to each square yard.

Five loads will give 63 lbs. to each square rod.

To find the number of loads of manure required to the acre, for a given number of lbs. per square foot.

RULE.—Multiply 43560 (the number of square feet in an acre) by the number of lbs. you wish to spread on each square foot, and divide the product by 2016, and the quotient will be the number of loads required.

EXAMPLE.—Required, the number of loads of manure to cover a 2-acre field, giving 2 lbs. of manure to each square foot?

SOLUTION.—$43560 \times 2 \times 2 = 174240 \div 2016 = 86.4$ loads. *Ans.*

ARTIFICIAL MANURES.

It is a self-evident truth that if we sell, we must buy, or we must be content to see our stock on hand reduced.

This principle applies nowhere else with more force than to the stock of mineral plant-food in the soil. This is, after all, our "stock in trade"—ammonia, carbonic acid, and water;—the sources of nearly ninety-nine-hundredths of our crops we can draw from the floating capital of the world, and, except in the case of ammonia, we need give ourselves but little trouble about them. With the mineral matters, however, the case is very different. Some of them, it is true, are so abundant and so universally distributed that they do not demand much attention; but some others, on the other hand, have been distributed by nature with so sparing a hand, that our constant care should be given to keeping our supply of them undiminished. They exist only in the soil; the winds cannot waft them to us, nor do they come, as ammonia does, in every summer shower. They are the hard currency of our banking system, and our business will always be limited by the amount we have in our vaults, and by the promptness with which we make good their loss when we have put them in circulation.

This fact has created a demand for *artificial manures*, the theory of whose production is, that the phosphate of lime which has found its way into the bones of animals, and has thus become, for the moment, unavailable to the farmer, shall be returned by some process which shall convert refuse bones into manure, or that it shall be replaced from some other source, as from the phosphatic guanos from which superphosphate of lime is largely made; and that potash, lime, &c., shall be collected, in the form of ashes, &c., &c., and returned to the soil.

If all the artificial manures that have been put into the market had been honestly made, the demand for them would have been much greater even than it now is.

But the fact that their composition can be ascertained only by careful chemical analysis, which farmers are incompetent to make, has led to no end of fraud, and one never knows, in purchasing a ton of superphosphate, poudrette, guano, &c., whether he is or is not paying for half a ton of coal-ashes or other worthless dirt. The consequence of this has been that many farmers have bought a little superphosphate as an experiment, have found no beneficial result from its use, and so have given it up as a bad job and pronounced the whole system of artificial manuring a swindle. The example of each man has had its effect on his neighbors, and there is, consequently, a wide-spread belief that all artificial manures are humbugs.

At the same time, there are so many who do fully understand the value of these fertilizers, and whose land absolutely needs their aid, that the manufacture and sale of such as are of established good quality has reached enormous proportions.

On farms where large stocks of cattle are fed, and for lands which are enriched by the raising of clover as a green crop, the necessity for the use of foreign manures is much less than where the crops are mainly sold off, and no recuperative process (such as the use of green crops) is adopted.

There is, in all fertile lands, a large reserve stock of mineral plant-food which is not yet in a proper condition to be taken up by roots, and if the cropping is not too severe—the produce being mainly consumed at home, and the manure economically used, or the frequent use of green crop manuring being resorted to—the gradual development, in an available form, of these mineral matters will maintain the land in a fair state of fertility for a very long time, and here the use of mineral manures is less obvious than in other cases.

It is a fallacy, however, to suppose that these lands do not *need* mineral manuring. By the system pursued, we are simply drawing on the capital stock, and, sooner or later, we shall touch bottom. It all looks fair enough now, but at some future day we or our successors must pay the penalty of our improvidence by finding that the land will no longer produce good crops without the use of more purchased manure than can profitably be applied to them.

The only safe rule (the only *honest* course, when we consider the fact that we are only life-tenants of our farms, and are in duty bound to leave them, unimpaired if not improved, to those who are to come after us) is to bring back on to the farm, every year, as much of the more valuable elements of vegetable ashes as we have sold off from it, whether in meat milk, grain, or hay. In this way only can we be sure that our land and our crops will each year improve.

The great deficiency of our older soils is in the items of phosphoric acid and potash. (Lime is more often needed as an agent for the development of matters already contained in the soil than as a direct food for plants.)

While ammonia has been classed among the non-essential elements of manure, its action as a stimulant is so remarkable that it is, commercially considered, the most valuable of all.

Professor S. W. Johnson of the Sheffield Scientific School, Yale College—the highest authority in America—gives the following as the analysis of the best *Superphosphate of Lime* that ever came under his examination :—

Analysis of Mapes' Improved Superphosphate of Lime. Manufacture of 1852.

Water	4.54
Organic and volatile matter	22.96
Sand and matters insoluble in acids	1.48
Soluble phosphoric acid	10.65
Insoluble " "	10.17
Ammonia	2.78
Phosphate of lime equivalent to phosphoric acid	45.11

The following is also from Johnson :—

Analysis of Coe's Superphosphate. Manufacture of 1856.

Water, organic and volatile matters	38.02
Sand and matters insoluble in acids	3.37
Soluble phosphoric acid	3.84
Insoluble " "	17.84
Ammonia	3.04
Phosphate of lime, equivalent to phosphoric acid	46.47

Johnson also gives the following analysis of *bone-ash*, or the residue of burnt bones :—

Analysis of Deburg's Bone Meal.

Water	3.04
Organic and volatile matters, mostly charcoal	2.07
Sand and insoluble matters	11.19

Lime	42.17
Phosphoric Acid	35.42
Carbonic "	1.23
Magnesia and sulphuric acid, with undetermined matters	4.88
	100.00

Also the following:—

Analysis of Bone Dust.

Water	8.75
Organic matter	27.25
Sand	5.37
Earthy phosphates	45.32
Carbonate of lime and loss	13.31
	100.00
Ammonia	2.98

Also the following:—

Analysis of Fish Guano, or the refuse of Fish Oil Works.

Water	9.67
Organic (animal) matter	67.78
Sand	2.05
Lime	3.76
Soluble phosphoric acid	3.38
Insoluble " "	.81
Ammonia yielded by animal matter	8.36

Purchasers of manures will find the following table—taken from Judd's Agricultural Annual for 1868—of great value, as affording a good *general* guide in determining the value of manure by the use of an analysis :—

Prices of Standard Fertilizers, and a Standard for Prices.

The prices of some of the standard fertilizers offered in the New York market simply as such, in December, 1867, are as follows :—

Peruvian Guano, in quantities of 50 tons, per long ton, (gold).......	$60.00
do do in smaller quantities the price varies with the premium on gold; with gold at 35 per cent. prem., per 2000 lbs........	85.00
Baker's or Jarvis' Island Guano—a phosphatic Guano from the S. Pacific Ocean, which should contain equivalent to 60 to 70 per cent. of bone phosphate of lime; per 2000 lbs..........................	45.00
Superphosphate of lime, per 2000 lbs..........................	55.00
Bone, fine ground, in 250 lb. bbls., per 2000 lbs..................	45.00
Flour of bone, per 2000 lbs....................................	60.00
Fine floated bone, per 2000 lbs.................................	65.00
Fish manure, dry and finely ground, per 2000 lbs.................	45.00
do unground, per 2000 lbs..........................	30.00
Gypsum or plaster, sold in quantities of 7 bbls., per bbl. (250 lbs)...	1.75
Shell lime, in bulk, per bushel.................................	.10
do per bbl..	1.50
Sulphuric acid of 66 degrees, (oil of vitriol) per lb................	2¾c.
do do of 60 degrees, (pan acid).........................	2¼c.

Carboys containing about 150 lbs. of this acid cost $3 each, and may be returned when empty.

The following table was prepared by John B. Laws, of Rothampstead, England. The money values of the manure resulting from feeding the several substances are based on the English (gold) prices of manure; they would be considerably higher here, but this does not affect their *relative* value.

Average Composition, per cent. and per ton, of various kinds of Agricultural Produce, &c.

	PER CENT.					LBS. PER (LONG) TON.					
	Total dry matter.	Total mineral matter (ash).	Phosphoric acid reckoned as phosphate of lime.	Potash.	Nitrogen.	Total dry matter.	Total mineral matter (ash).	Phosphoric acid reckoned as phosphate of lime.	Potash.	Nitrogen.	Value of manure in $ & cts. from 1 ton (2000 lbs.) of food.
1. Linseed cake	88.0	7.00	4.92	1.65	4.75	1,971	156.8	110.2	37.0	106.4	19.72
2. Cotton-seed cake	89.0	8.00	7.00	3.12	6.50	1,994	179.2	156.8	70.0	145.6	27.86
3. Rape cake	89.0	8.00	5.75	1.76	5.00	1,994	179.2	128.8	39.4	112.0	21.01
4. Linseed	90.0	4.00	3.38	1.37	3.80	2,016	89.6	75.7	30.7	85.1	15.65
5. Beans	84.0	3.00	2.20	1.27	4.00	1,882	67.2	49.3	28.4	89.6	15.75
6. Peas	84.5	2.40	1.84	0.96	3.40	1,893	53.8	41.2	21.5	76.2	13.38
7. Tares	84.0	2.00	1.63	0.66	4.20	1,892	44.8	36.5	14.8	94.1	16.75
8. Lentils	88.0	3.00	1.89	0.96	4.30	1,971	67.2	42.3	21.5	96.3	16.51
9. Malt dust	94.0	8.50	5.23	2.12	4.20	2,106	190.4	117.1	47.5	94.1	18.21
10. Locust beans	85.0	1.75	......	....	1.25	1,904	39.2	......	....	28.0	4.81
11. Indian meal	88.0	1.30	1.13	0.35	1.80	1,971	29.1	25.3	7.8	40.3	6.65
12. Wheat	85.0	1.70	1.87	0.50	1.80	1,904	38.1	42.0	11.2	40.3	7.08
13. Barley	84.0	2.20	1.35	0.55	1.65	1,882	49.3	30.2	12.3	37.0	6.22
14. Malt	95.0	2.60	1.60	0.65	1.70	2,128	58.2	35.8	14.6	38.1	6.65
15. Oats	86.0	2.85	1.17	0.50	2.00	1,926	63.8	26.2	11.2	44.8	7.70
16. Fine pollard*	86.0	5.60	6.44	1.46	2.60	1,926	125.4	144.2	32.7	58.2	13.53
17. Coarse pollard†	86.0	6.20	7.52	1.49	2.58	1,926	138.9	168.4	33.4	57.8	14.26
18. Wheat bran	86.0	6.60	7.95	1.45	2.55	1,926	147.8	178.1	32.5	57.1	14.59
19. Clover hay	84.0	7.50	1.25	1.30	2.50	1,882	168.0	28.0	29.1	56.0	9.64
20. Meadow hay	84.0	6.00	0.88	1.50	1.50	1,882	134.4	19.7	33.6	33.6	6.43
21. Bean straw	82.5	5.55	0.90	1.11	0.90	1,848	124.3	20.2	24.9	20.2	3.87
22. Pea straw	82.0	5.95	0.85	0.89	....	1,837	133.3	19.0	19.9	20.2	3.74
23. Wheat straw	84.0	5.00	0.55	0.65	0.60	1,882	112.0	12.3	14.6	13.4	2.68
24. Barley straw	85.0	4.50	0.37	0.63	0.50	1,904	100.8	8.3	14.1	11.2	2 25
25. Oat straw	83.0	5.50	0.48	0.93	0.60	1,859	123.2	10.7	20.8	13.4	2.90
26. Mangel wurzel	12.5	1.00	0.09	0.25	0.25	280	22.4	2.0	5.6	5.6	1.07
27. Swedish turnips	11.0	0.68	0.13	0.18	0.22	246	13.4	2.9	4.0	4.6	0 91
28. Common turnips	8.0	0.68	0.11	0.29	0.18	179	15.2	2.5	6.5	4.0	0.86
29. Potatoes	24.0	1.00	0.32	0.43	0.35	537	22.4	7.2	9.6	7.8	1.50
30. Carrots	13.5	0.70	0.13	0.23	0.20	302	15.7	2.9	5.1	4.5	0.80
31. Parsnips	15.0	1.00	0.42	0.36	0 22	336	22.4	9.4	8.1	4.9	1.14

* Middlings, Canielle. † Shipstuff.

TILE DRAINING.

I have preferred to head this article as I have, rather than to say simply "draining" or "under-draining," because I believe in the use of tiles under all circumstances when it is possible to procure them, and because the making of stone drains is understood by every farmer who lives in a region that is blessed with wet land and stone.

At the same time, I would not be thought to undervalue the usefulness of stone drains. Neither the stone nor the tile has any influence, in itself, on the fertility of the soil. Any material by the use of which we can make a passage-way through the soil will make a perfectly good drain, *as long as it keeps the passage open.*

The question is to be decided simply by the consideration of cost and durability; and here the tiles have an immense advantage.

In the first place, they are very much *cheaper* than stone; and in the second, the drain which they make is very much more likely to be permanent.

It will, I am aware, strike many farmers whose land is encumbered with stones, as a singular proposition that it is cheaper to pay twenty-five or thirty dollars per acre for tiles, when there are stones on the place that it would be an advantage to get rid of But it is a fact, nevertheless. The cost of collecting the stones, of breaking (or selecting them) to a proper size, of laying them in the drain, and of protecting them from the rattling down of loose dirt among them, and from the burrowing down of field-mice, is very great, and in addition to this we have to calculate the cost of digging the very much wider ditch that is required for their use.

To drain land in the best manner there are required about sixty rods of drain four feet deep, and fifty cents a rod for the above items (which is the utmost that tile should cost) would not pay one-half of the actual cost of stones, if we calculate the labor of teams and men at anything approaching their full value.

As to durability. A tile drain, when properly laid, is packed closely in the most compact subsoil within our reach, has its joints (which are very close) encased in an earthen collar, is closed at its upper end by a flat stone against the tile, and its outlet secured by a grating. No dirt can get in to stop it up, and no vermin can use it for a camping ground. The only thing (except in rare instances the roots of trees) that can enter it at all is the water that it is intended to carry away.

Of course I speak of a tile drain that is made of good materials and is made in a proper manner. It is very easy to make a drain that will not be worth the cost of the tiles, not worth anything; and many such drains are made by careless or ignorant people, who, seeing their uselessness, are loud in the praise of stone drains, and never want to see another draining tile so long as they live.

A *good* tile-drain, made of good clay and well burnt, properly laid on a uniform descent, *and having a good outlet,* is practically as permanent as the earth in which it is imbedded.

And now, *how to make such a drain.* It would take much more than the few pages that can be here devoted to the subject to tell. All that my space will allow me to do is to give a few general rules and directions, which will suffice to enable a farmer to understandingly decide for himself whether he will make his drains of stones or of tiles; and a few arguments which may convince him that he *cannot afford* to let his wet land go undrained.

The draining tile is made in several forms, known as the "round," the "sole," and the "horse-shoe." The last mentioned represents the first step that was taken in advance of the use of stones, and it has long been condemned as an inferior article by all who have had experience in the use of the other kinds. The sole-tile, which has an egg-shaped orifice, and has a flat side to lie upon, is theoretically very good, and is really very good, only not the best. The flat side is a delusion, for the reason that it generally is *not flat,* being very liable to be warped out of shape in the burning, while the uneven drying of the clay before it is burnt, or the friction of the die through which it is moulded, is very apt to so distort its shape as to make it difficult to make a good joint.

The round tile, if well made, is much better, is practically perfect. A tile does not need a flat side to lie upon, for in nine cases out of ten the bottom of the ditch is not flat, and as soon as each piece is put in its place, and while it is held there by the tile-layer, a second man covers it sufficiently to hold it firmly. The smaller sizes have collars or rings to fit them, and these keep the joints "in line" and prevent loose dirt from rattling into the wider openings. Another great advantage of the round tiles is that, if they don't fit each other as they are first laid, they can be turned over until the slight inequalities of the two ends will correspond.

All of the larger tile makers now make the round tiles, and most of them make them very well. A machine invented by Mr. Tiffany (of the Crosmann Clay and Manufacturing Company, Woodbridge, New Jersey) moulds the tiles more smoothly, and presses them harder, than any other yet brought into use. Mr. C. W. Boynton, of Woodbridge, however, seems to have brought more real talent to the manufacture of tiles than any one else who has undertaken the business, and his pipes are probably the best now made, inasmuch as they are two feet long—twice the usual length—and are supplied with connecting pieces for admitting lateral drains into the main trunk lines. Heretofore it has been the custom to pick a hole in the side of the tile of the main drain, and to bring the end of the lateral against it, closing the irregular openings by covering them with bits of broken tile or small stones; and it was nice work to avoid breaking the pipe, and at the same time to make the joint so accurately as to neither retard the flow nor to admit earth from the filling.

Boynton's pipes, which are shown in the accompanying cuts, have a branch piece nicely fitted to the side of the pipe that is to form a part of the main, the branch forming a part of the lateral. On the end of this branch a collar may be placed to receive the end of the lateral, making as good a joint at the junction as at any other part of the drain.

Before this improvement was made, it was often necessary, where a tile came into the main, to make a silt-basin to catch any silt that might be deposited by the more sluggish flow of the water at that point. By its aid these silt-basins may be, in nearly all cases, dispensed with, as the lateral enters in an oblique direction, and the velocity of its flow will be imparted to that of the main.

FIG. 1.

FIG. 2.

FIG. 3.

Fig. 1 shows the round tile; Fig. 2, the collar; Fig. 3, the manner of laying these; Fig. 4, the connecting joint of the main with a branch to receive the lateral; and Fig. 5 the

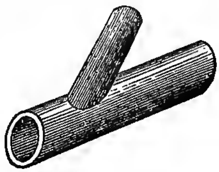


FIG. 4.

manner of laying the tiles at the junction of a lateral drain with the main.

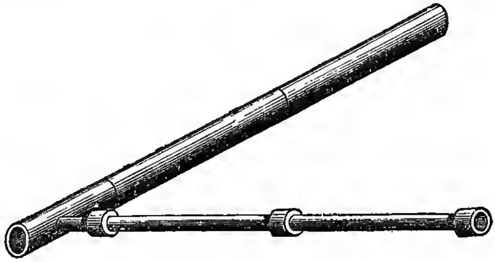


FIG. 5.

Rules to be observed in making Tile Drains:—

1. Every drain (unless there is some special reason to the contrary) should run directly down the steepest descent of the land—not obliquely, but straight down the hill.

2. Wherever possible, the drains should be four feet deep, *especially* when the subsoil is a stiff clay hard-pan.

3. When the drains are four feet deep, they should be forty feet apart. If only three feet deep, they should be only twenty feet apart; and if more than four feet, they may safely be placed at greater distances than forty feet.

4. The rate of fall or inclination of a drain should not decrease as it approaches the outlet. It may be increased as much as is convenient. The rule is, to keep the water running faster and faster, rather than slower and slower, as it gets on in the drain.

5. The outlet should always be clear and free—never, if it can possibly be avoided, so arranged as to be obstructed by mud or dead water.

6. The tiles should have no porous material of any kind over them, but should be imbedded (and firmly packed) in the closest clay that is accessible.

7. In digging the ditch, always commence at the lower end and work toward the top; in laying the tiles, commence at the upper end, and continue toward the outlet.

8. Never have tiles laid by the piece (or rod), but always by the day, and by the most faithful and careful man that can be found; if possible, do it yourself, and remember that the golden rule of draining is that, *as the weakest link of a chain is the measure of its strength, so is the worst laid tile of a drain the measure of its goodness.**

If the drains are laid at distances of forty feet it will take just about one thousand feet of tiles to drain an acre.

As to the sizes of tiles required, it will make a difference whether the fall is rapid or slight; but under all ordinary circumstances, where there are no springs to be disposed of, only the natural drainage of the land itself (its accumulated

* Talpa, or the Chronicles of a Clay Farm.

rain-fall), the first 1500 feet in length, whether it be a single drain or several laterals, may be made of the smallest sized tiles (1½ inch). Beyond this amount and up to 5000 feet, 2-inch tiles will suffice. From 5000 to 10,000 feet use 3-inch, and from 10,000 to 20,000 feet use 4-inch.

These sizes would not suffice for the immediate removal of all the water of a very heavy rain-fall, but it is to be remembered that before the water can get to the tiles it must filter slowly through four feet of soil, and could reach the drain but slowly, were it ever so large. Then again, it is not important that the water of a heavy rain be removed within an hour of its falling; it does no harm to have it settle slowly away, so long as it really does settle away, and does not stand to be evaporated from the surface, nor to flow off over it; and it is desirable that the drains should occasionally run "more than full," so that a strong flow of water may wash out any obstructions that may have accumulated in them.

The question should not be so much how large a tile is necessary to carry the water, as how large a tile will the water (after heavy rains) be able to flush and keep clean.

In the foregoing, I have simply stated rules and principles which have been proven by long experience to be correct. The evidences of their truth and reliability, and the arguments on which they are founded, could not be set forth in the limited space which has been allowed for the subject in this book. The object here is to set forth rules and to give

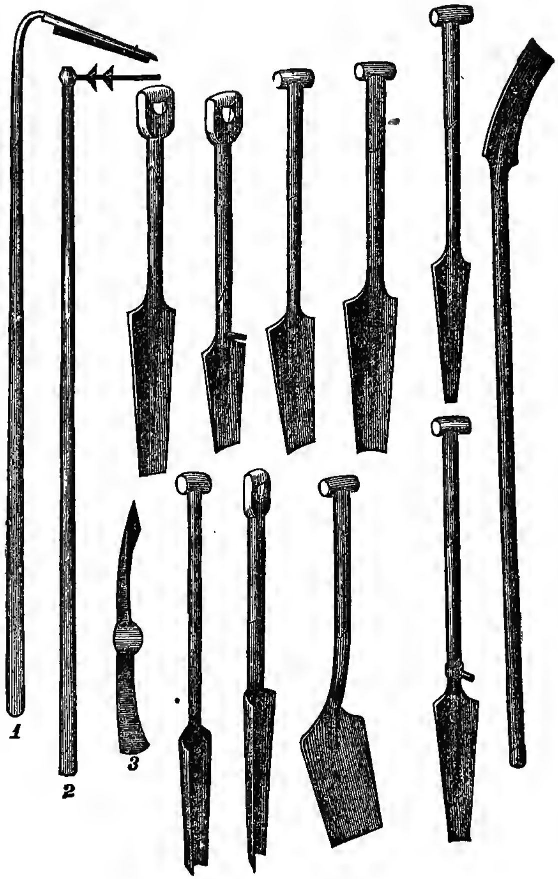


FIG. 6.

Tools used in laying drain tile.

directions. Those who are desirous of investigating reasons will find them stated in other works which are devoted to the fuller discussion of the various topics here touched upon.

The ditches are usually dug, in this country, with the ordinary pick, spade, and shovel, with the single addition of a narrow scoop to work in the narrow bottoms of the drains. Such a scoop may be made by cutting a common, round-pointed, long-handled shovel down to a width of four or five inches.

In Europe, where much more extensive operations of drainage are carried on than are known in this country, sets of tools especially adapted for all the different operations are used. One set of these is shown in Fig. 6.

FIG. 7.

The position of the workman in cutting a narrow ditch for a tile, or rather in finishing the bottom of the ditch with the scoop, is shown in Fig. 7.

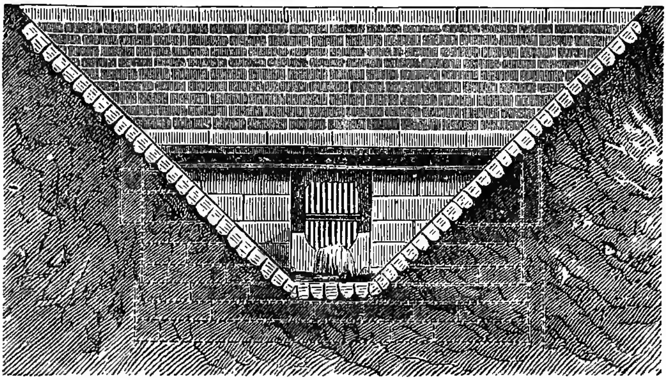


FIG. 8.

The manner of securing the outlet so as to keep out ver-

FIG. 9.

min, and, at the same time, to prevent the earth from caving in about the end of the drain, is shown in Fig. 8.

The manner in which draining tiles are moulded from moist clay may be learned from Fig. 9, which represents a strong wooden box filled with clay, which, by the pressure of a lever, is forced out through holes which have the shape of the outside of the tile. A plug stands in the middle of each hole (supported from within, so that the clay can entirely surround it as it comes out), which makes the bore of the tile.

WHY SHOULD LAND BE DRAINED?

There is one condition of soil that is the most favorable for the growth of nearly all agricultural plants—that is a condition of porousness, moisture, warmth, and aëration. The roots of plants need to be in a *dark* place, to be *surrounded by moisture* (this is very different from being soaked in water), and to be sufficiently supplied with air.

There are other conditions of fertility, such as richness in plant-food, &c., which, although of the utmost importance, are apart from our present subject. What we have now to do with is the *mechanical* state of the soil, as distinguished from its chemical composition and action—that is to say, with its moisture, its temperature, the ease with which roots can penetrate it in search of nutriment, and the opportunity for the admission of atmospheric air to their vicinity.

The effects of drainage on the chemical constitution of the soil, and on the chemical action of its ingredients as affecting vegetation, is very great; but it is not necessary to the strength of the argument that they should be detailed here, and their sufficient discussion would require too much space.

Moisture.

By the moisture of the soil we mean a condition resembling that of a sponge which has been dipped in water and then lifted out and allowed to drain. While in the water it was saturated—that is, all of its pores were *filled* with water—but on being removed the water all runs out from its pores, except the small amount that adheres (by capillary attraction) to its substance.

In like manner the undrained soil, after a heavy rain, is saturated. All of the spaces between its particles are filled with water. After draining, this water all passes away, except the small amount which adheres to the surfaces of the particles, and that which fills the more minute pores of these particles. There is enough water in the soil in this condition to supply the demands of plants; but there is not —as there was before draining—so much as to interfere with their healthy growth.

Not the least beneficial effect of draining is that which is the result of the admission of air to its lower and cooler parts, causing a deposit of moisture in dry weather, which is sufficient to supply the needs of vegetation, and to greatly mitigate, if it does not even entirely overcome, the effects of drought.

That land should be made damper by being made more dry, that under-draining should be one of the best preventives of the ill effects of drought—this is the apparently anomalous proposition on which one of the strongest arguments in favor of draining is based.

When we see a field baked to the consistence of a brick, gaping open in wide cracks, and covered with a stunted growth of parched and thirsty plants, it seems hard to believe that the simple laying of hollow tiles, four feet deep, in the dried-up mass, would do anything at all toward the improvement of its condition; for the present season it would not, but for the next it would, and for every season thereafter, and in increasing degree, so long as the tiles continued to act as effective drainage.

The baking and cracking, and the unfertile condition of the soil are the result of a previous condition of entire saturation. Clay cannot be moulded into bricks, nor can it be dried into lumps unless it is first made soaking wet. Dry, or only damp clay, once made fine, can never again be made lumpy, unless it is first made thoroughly wet, and is pressed together while in its wet condition. Neither can a considerable heap of pulverized clay, kept covered from the rain, but exposed to the sun and air, ever become even apparently dry, except within a few inches of its surface. After under-draining has had time to bring the soil, to a depth of two or three feet, to a thoroughly drained condition, it will equally prevent it from being baked into lumps, or from becoming, for any considerable depth below the surface, too dry for the purposes of vegetation. In the first place, the water of heavy spring rains, instead of lying soaking in the soil until the rapid drying of summer bakes it into coherent lumps, settles away and leaves the clay, within a few hours after the rain ceases, and before rapid evaporation commences, too much dried to crack into lumps.

The other direct effect of under-draining is to remove from below, water which, if not so removed, would be evaporated from the surface.

The formation of a crust on the surface of the ground is in direct proportion to the quantity of water that is removed by evaporation, and the crust constitutes a barrier against the admission of air. Consequently the larger the quantity of water that is removed by the drains, the smaller is the obstacle offered to the entrance of air. The more constantly the lower parts of the soil are relieved from excess of water and supplied with air, the more deeply will roots descend; and the more frequently will the air in the lower soil be changed, the easier its communication with the atmosphere.

On these two principles depends the immunity from drought which under-draining helps us to secure. In dry weather the soil gets its moisture from the deposit of dew, on the surface during the night, and on the surfaces of the particles of the lower soil constantly, day and night.

Temperature.

The temperature of the soil is a matter of the utmost consequence. Seeds cannot germinate, and plants cannot grow without there being a certain amount of heat in the soil, and there is no means by which this heat is so much and so constantly reduced as by the evaporation of water from its surface. In proportion as we remove by the means of under-draining the water which would, if not so removed, remain to be evaporated, we allow the soil to attain a higher temperature, and so to become more productive.

The penetration of roots.

In a soil that is usually *too wet*, the roots of plants confine their operations to the few inches of dry soil at the surface, as they will not push into a cold, compact, wet subsoil. Draining removes the water from the subsoil, allows it to become sweet and warm and loose, and fit for the entrance of roots, which are thereby enabled to seek farther for a greater quantity and a greater variety of food.

The circulation of air.

Atmospheric air, if not absolutely necessary to the life and action of the roots of plants, greatly favors their growth and their absorption of food. Aside from its direct supply of carbonic acid to the feeding parts of the roots, it brings moisture to the soil by which they are surrounded, and aids in preparing its nutrient constituents for assimilation.

ROTATION OF CROPS.

The experience of practical farmers very early demonstrated the necessity for adopting a system of changes in the crops grown on the same soil. Thus, we find in the writings of Columella, Varro, Theophrastus, and others who in ancient times wrote on the subject of agriculture, distinct rules laid down as to the course of cultivation to be pursued in order to prevent the exhaustion of the soil, or, rather, to prevent it from failing to produce a particular crop so long as it was fertile for anything, and to enable it to make full use of whatever manures were applied to it.

In more modern times, the *reasons why* rotations are necessary have been, in a measure, explained by the aid of chemistry, but we have not materially improved on the *practice* of those who cultivated the soil 2000 years ago.

The various crops appropriate different elements from the soil, or the same elements in different proportions. Of course, by raising the same crop year after year from the same field, its quantity and quality not only yearly deteriorate, but the soil becomes exhausted of the special ingredients which go to support the growth of that particular product, while it accumulates the elements especially adapted to some other crop.

The principle on which rotations are based may be readily understood from the following illustration :—

What are known as the root crops contain, in their ashes, a very large proportion of potash. The average amount of this substance contained in the ash of potatoes, turnips, beets, and carrots, is fully *fifty per cent.* of the whole; that is, they contain as much of this single ingredient as of all the other mineral ingredients combined. Wheat, rye, oats, and barley, on the other hand, contain an average of only *twenty-five per cent.*, or only one-half as much of this as of all the other ingredients.

If we examine their content of phosphoric acid, however, we shall find the case quite different. For instance, the four root crops above named contain an average of only about *thirteen per cent.* of this element, while the four grain crops contain an average of about *thirty-seven per cent.*

Again, lime forms but about *three per cent.* of the ash of most root crops, while it exists in clover and most of the fodder plants to the extent of about *thirty-five per cent.* of their ash.

If we were to follow through the whole range of the mineral constituents of our crops, we should find similar variations in the amounts appropriated by the different plants which are commonly grown on our fields.

Now, suppose that on a field of average quality we find that wheat or some other grain grows to advantage. Stimulated by the profits of the cultivation of this grain, we continue to grow it year after year, without intermission. The result is that—sooner or later, often within two or three years—we find the yield steadily diminishing. One reason for this is that we have been constantly robbing the soil of undue amounts of phosphoric acid, and (without rendering it unfertile for some other crops, such as potatoes) we have seriously impaired its capacity for the production of wheat. If, instead of raising wheat the second year, we had raised potatoes, or clover, or some plant of an entirely different character from wheat, we should have drawn more evenly on *all* of the resources of the land, and should have postponed the exhaustion of its stock of available phosphoric acid.

Here then comes in play, also, another element which it is necessary for the farmer to consider, namely:—there are constantly going on in the soil (which may be considered a natural chemical laboratory) certain chemical and mechanical processes, whose effect is to continually set free from other combinations and prepare for the use of plants the various minerals which constitute their ashes. Therefore, if we bring a grain crop into the rotation only once in four, five, or six years, the simple action of these processes will, in the intervening time, set free enough phosphoric acid for a second crop. Soils differ, not only in their composition, but in the rapidity with which their elements are set free; consequently we find some soils on which the same crop may safely be tried every second or third year, and others on which we must allow a much longer interval.

The same rule that applies to the soil holds good also with regard to manures. These almost always contain various matters which go to feed plants, and we must study to so arrange our crops as to make profitable use of all that they can yield; and, if they are of a sort to need time and the action of the chemical and mechanical influence of the atmosphere and of the soil for the complete development of all of their constituents, we must adjust our crops, so far as possible, to take up these constituents as they are prepared for use.

The foregoing is the basis of the chemical theory of rotations.

In addition to this, we must consider the influence exerted on the soil by the roots which are left in the ground when the crop is removed. This element of the influence which plants exert on plants which are to follow them in the same soil is especially important in the case of clover, which is so active in its fertilizing effect, that it may be assumed that we have overcome our great difficulty in bringing up a poor soil when we have enabled it to grow a good crop of clover. One especial virtue of this plant is that it sends its roots far into the subsoil, and thus appropriates, by means of its vigorous feeding powers, useful materials which were out of the reach of the roots of plants of other species. These materials are deposited in the substance of the plant, and (on its decay when ploughed in, or on the decay of its roots when these alone are left in the soil) they are presented to the new crop in a most acceptable form. The raising of other green crops to be ploughed in for manure, is advantageous for the same reasons.

Two most valuable accessions to the rotation of crops will be found in the root crops, and in green forage crops to be either cured for winter use or fed to animals kept on the "soiling" system. To these crops the richest animal manures may be profitably applied, and, while they will make a most luxuriant growth, they will "draw the fire" of the manure, and leave the land in the best condition for the growth of grain crops.

Copeland says:* "When it was discovered that roots of all kinds were not only good food, but the best food for cattle, those farmers who believed in the discovery cultivated roots, and found, not only that their value as food was inestimable, but that, with a given expenditure in manure and labor, roots gave a larger return in value than any other crop. This was the turning point, the rising tide-wave of improving agriculture. The new crop was an improvement in every respect. It restored fertility better than the fallow, gave an immense amount of fodder, and insured a corresponding increase in manure, from the greater number of cattle which could be fed from the farm.

"Under the old system—the same pursued in New Eng-

* Country Life, page 435.

land at the present day—there was a large and a small white crop, one large yield of hay, then smaller and smaller, then good pasture, then poor. This rotation gave a change from better to worse. The new practice demonstrated that there need be no "worse." It showed that a root crop should follow the sod and should be followed by grain; that again by grain or grass and clover; that by pasture and roots. At first it was made a point that a white crop should never be taken two years in succession, and after going through roots and grass it was found, on returning to the white crop, that the ground was so much richer than before, that a number of bushels was taken previously unheard of in the neighborhood."

Liebig says:* "The succession of crops in rotation is always made dependent upon the cereals; the preceding crops are selected of such a kind that their cultivation will not injure, but rather improve the succeeding corn crop. The selection of the particular kind, however, is always governed by the condition of the soil. In a field abounding in stalk and leaf constituents, it is often found useful to have wheat preceded by tobacco or rape, rye by turnips or potatoes, since these plants, by drawing from the soil a large amount of leaf and stalk constituents, serve to restore a more suitable proportion between the straw and corn constituents for the future cereal crop, and, at the same time, to diminish in the arable soil those conditions which favor the growth of weeds.

* The Natural Laws of Husbandry, page 227.

Prof. James F. W. Johnston says:* "Two practical rules are suggested by the fact that different plants require different substances to abound in a soil in which they shall be capable of flourishing.

"1. To grow alternately as many different *classes* or *families* of plants as possible, repeating each class at the greatest convenient distance of time. In this country (England) we grow, chiefly, root crops—corn plants refined for seed—leguminous plants, sometimes for seed (peas and beans), and sometimes for hay or fodder (clover and tares), and grasses; and these in alternate years.

"Every four, five, or six years, therefore, the same class of plants comes round again, and a demand is made upon the soil for the same kinds of food in the same proportion. * * * * * A perfect rotation would include all those classes of plants which the soil, climate, and other circumstances allow to be cultivated with a profit.

"2. A second rule is, to repeat the same *species* of plants at the greatest convenient distance of time. * * * * *

"Instead, therefore, of a constant repetition of the turnip every four years, theory says, make the carrot or the potato take its place now and then, and instead of perpetual clover, let tares, or peas, or beans occasionally succeed to your crops of corn.†

* Agricultural Chemistry, page 493.

† "*Corn*, in English agricultural writing, is a general term corresponding to our *grain*."

"The land loves a change of crop because it is better prepared with that food which the new crop will relish than with such as the plant it has long fed before continues to require.

"It is for this reason that new species of crop or new varieties, when first introduced, succeed remarkably for a time, and give great and encouraging returns. * * * *

"It is constant variety of crops which, with rich manuring, makes our market gardens so productive, and it is the possibility of growing in the fields many different crops in succession that gives the fertility of a garden to parts of Italy, Flanders, and China."

The rotation to be adopted may be best selected by each farmer for himself—keeping in mind the foregoing principles—with reference to his soil, his market, his climate, the price and supply of labor in his neighborhood, and the extent to which he can accumnlate manure.

The rotation which the writer has adopted for his own farm is the following:—

First year:—Indian corn, on sod land, manured the previous autumn with the entire accumulation of manure in the barn cellar, then ploughed and left in the rough furrow for the fullest exposure to frost, harrowing thoroughly before planting time.

After the crop is taken off in the fall, the land to be ploughed and again left in the rough furrow to winter.

Second year:—Roots, the ground being properly divided between carrots, mangel wurzel, turnips, and parsnips.

For this crop the land is cross-ploughed in the spring, dressed with one-half of the winter's accumulation of manure in the cellar, and from 100 to 250 lbs. of superphosphate of lime, both sowed broadcast on the furrow and thoroughly harrowed in.

Third year:—Green forage crops for "soiling" cattle—mainly oats and Indian corn in successive sowings.

These crops receive the balance of the winter's manure, and a good portion of the land is cleared off in time for winter rye to be sown.

Fourth year:—The winter rye is cut green, very early in the season, for "soiling" the cattle, and on the land not occupied with it a crop of green fodder is grown that can be got off by August 1st.

In the early autumn the land to be sown to wheat, and seeded down with timothy and clover.

Fifth year:—The grain harvested and the growth of grass and clover left on the land.

Sixth year:—Two cuttings of hay to be taken off, and the land to be manured and ploughed in the fall for the succeeding crop of corn, with which the rotation recommences.

PROPERTIES AND COMPOSITION OF MILK, BUTTER, &c.

Composition of Milk in 1000 *parts.*

Water	840
Casein	40
Milk-sugar	45
Butter, or oil	40
Phosphate of lime	17
Phosphate of magnesia	4
Chloride of potassium	9
Common salt	2
Free soda	3
	1000

NOTE.—Milk is heavier than water in the proportion of 103 to 100.

The rapidity with which cream rises to the surface depends upon the temperature to which it is exposed.

New milk, set aside, will cream in

36 hrs.	if the	temperature	of the air	is	50°	Fahrenheit.
24 "	"	"	"		55°	"
18 to 20 "	"	"	"		68°	"
10 to 12 "	"	"	"		77°	"

At a temperature of 34° to 37°, it may be kept two to three weeks without throwing up any noticeable amount of cream.

Cream contains the greater part of the fatty matter of the milk, a small portion of the curd, and considerable water.

Good cream, when skilfully churned, will yield about one-fourth of its weight of butter.

The temperature at which *milk* can be churned most economically is 65° Fahrenheit.

The temperature at which *cream* can be churned most economically is at 58° Fahrenheit.

Butter contains more or less of all the ingredients of the milk. Essentially it consists of the fat of milk mixed with about one-eighth of its weight of water, a small quantity of casein or curd (cheesy matter), and of saline matter. The casein seldom exceeds two per cent. of the whole weight.

The *fat of butter*, when solidified by pressing out the oil, is identical with the solid fat of the human body.

The *oil of butter* is a peculiar kind of fat not hitherto detected in any other substance.

These two ingredients vary considerably with different samples ; hence the different degrees of *hardness* which different samples present. The solid fat abounds more in winter ; the liquid fat more in summer. They are in about the following proportions in 100 parts :—

	Summer.	Winter.
Solid fat..........................	40	65
Oil of butter..........................	60	35

The main cause of butter becoming rancid is the chemical decomposition which the casein or curd it contains undergoes by exposure to the air. This chemical change in the cheesy matter may be prevented—

1st, By thoroughly washing and salting before the cheesy matter has had time to become altered by exposure to the air;

2d, By taking care that any water that may remain in or around the butter be kept perfectly saturated with salt;

3d, By carefully excluding the air from the vessel in which the butter is packed.

About half a pound of the best Ashton salt is used to 10 pounds of butter.

Milk contains a peculiar kind of sugar called milk-sugar, which, being highly soluble in water, passes off in the whey and goes to fatten pigs. In some countries it is extracted and made an article of commerce.

The main cause of milk becoming sour is the chemical change which this sugar undergoes, without fermentation and therefore without loss, into an acid called lactic acid.

This lactic acid is the cause of the *curdling* of the milk, which may be hastened by hastening the change of the milk-sugar into lactic acid by the addition of any other acid, such as vinegar or rennet.

Pure casein is nearly insoluble in pure water, either by boiling or otherwise. By adding, however, a little soda to the water, it dissolves and returns to its milky condition;

when, by adding some more milk-sugar (or lactic acid), it again curdles.

The milk of nearly all animals contains the same ingredients. The best known varieties consist nearly of—

	Woman.	Cow.	Ass.	Goat.	Ewe.
Casein........	1.5	4.5	1.8	4.1	4.5
Butter........	3.6	3.1	0.1	3.3	4.2
Milk-sugar....	6.5	4.8	6.1	5.3	5.0
Saline matter..	0.5	0.6	0.3	0.6	0.7
Water........	87.9	87.0	91.7	86.7	85.6
	100.	100.	100.	100.	100.

The butter and cheese producing quality of milk is shown by the following

TABLE.

100 lbs.	milk	contains	about	3	lbs.	pure butter.
100 lbs.	"	"	"	7.8	lbs.	" cheese.
100 lbs.	"	averages	"	3.5	lbs.	common butter.
100 lbs.	"	"	"	11.7	lbs.	" cheese
100 lbs.	skim-milk	yields	"	13.5	lbs.	skim-milk "
1 qt.	wine measure	weighs		35	oz.	
1 qt.	milk	"	"	41	oz.	

The milk of different cows varies much in richness. We have known one from 65 lbs. of whose milk were made 64 oz. of butter. A full milk cheese contains about 33 per cent. of water, and a skim-milk cheese about 60 per cent.

Butter at 50 cents per pound will yield about as much profit as cheese at 15 cents, making no allowance for the value of skim-milk over whey.

BUTTER AND CHEESE-MAKING.

The Butter Dairy.—The quality of butter doubtlessly depends more upon the manufacture than upon all other causes combined, yet it is true that the cows, the grass or food, and the water, have much to do with the delicacy of its flavor and richness of its color. It is a notorious fact that eight-tenths of the butter that is sold in the market brings from *five* to *fifteen* cents per pound less than it would have done had it been properly manufactured. Factory cheese for the same reason brings from *three* to *eight* cents per pound more than dairy. It costs no more to make a good article than an inferior one, and when this fact is fully appreciated, thousands of dollars will be saved annually to the dairyman farmer.

Milk-room.—The best milk-room is one through which a stream of pure spring water flows, and a reservoir under the "pan rack" is very desirable. When this cannot be had, select a room or building on the north side of the house, through which fresh air can freely circulate. If a cellar is chosen, it should be dry and thoroughly ventilated by large latticed windows and doors. No decaying vegetables should be allowed to remain in it, as the milk and cream easily become tainted. Close and damp cellars are entirely unfitted for a milk-room, and should not be used. The temperature of the milk-room should be as uniform as possible, ranging from 55° to 65°. When the weather is cold, a fire should be kept in a stove on which a basin of pure water is placed, to prevent the air from becoming so dry as to form a crust on the cream. When too warm the temperature can be reduced by hanging wet linen sheets near the doors and windows, the lower edges of which dip into a vessel of water.

Cleanliness.—In every department of butter-making the utmost cleanliness should be observed. Milk and cream rapidly absorb noxious gases, and are especially affected by the acids and gases which arise from the decomposition of sour milk or cream. Every utensil used in connection with the dairy should be scalded every time used in boiling water, in which, occasionally, a small piece of bicarbonate of soda has been dissolved. All traces of milk or cream accidently spilled on the floor should be carefully removed.

Setting the Milk.—As soon as the milk is drawn from the cow it should be strained into the setting pans, to a depth of not over two inches. The complete raising of the cream, especially in warm weather, is thus greatly facilitated. In summer the temperature of the milk should be reduced as soon as possible to about 62°. Powdered ice put into the pail before straining is best; setting the pail in cold spring or well-water for a few minutes will answer. A small piece of crystallized soda about the size of a common acorn, dissolved in a little water, put into each pail of milk before straining, to correct the acidity as it is formed, will increase the quantity of cream, and improve the quality of the butter. Milk, if kept at the proper temperature, need not stand over thirty-six hours. If the cream does not rise in that time, the quality of the butter will be impaired by the formation of a bitter acid, which gives to the butter a disagreeable flavor. In winter the quantity of cream will be increased, and its quality improved, by bringing the milk to a temperature of about 120° before setting.

Cream.—As soon as the cream is taken from the milk it should be placed in stone jars or tin pails and set in a cool place. Sprinkle a small handful of fine salt over the top of the cream, and let it stand until churned. Should there be any milk at the bottom of the jar it should be separated from the cream, for the cheesy particles of the sour milk become mixed with the butter during the process of churning, and give it the white cheesy appearance which is sometimes observed when the butter "comes white." The cheese decomposes upon exposure to the air, and renders the butter rancid. Such butter should never be packed with the good, for it will surely spoil the whole; "a little leaven will leaven the whole lump."

Churning.—The proper temperature at which to churn cream is from 55° to 60°, and care should be taken that the cream be "washed down" so that all will granulate at the same time. When the butter "has come" to the size of peas, draw or pour off the buttermilk, and pour into the churn a pail of cool water, and thoroughly "gather" by the aid of the "dasher" the butter into a compact mass; after which remove it to the butter-bowl. It should be again washed until the water is free from the least trace of milkiness, and then salted. Use the best Ashton salt, and if free from water one-half pound of salt is sufficient for 10 pounds of butter. Common salt should never be used, for it contains impurities which injure the butter. The cheapest salt in this case is certainly not the most economical. While the salt is being worked in, if too soft let it stand in a cool place not over three or four hours, then work again and pack. While working, absorb all the moisture from the butter with a sponge covered by a linen cloth, previously moistened in cold water, and continue to work until all the brine is absorbed. No milky brine * should be allowed to remain in the butter, for it decomposes and injures it. During the process of working the temperature of the butter should not be higher than 55° or 58°. When it becomes warmer than this it looses its waxy, granular appearance, and becomes sticky and greasy. When the salt is not thoroughly worked in, the butter will have a streaked or marbled appearance.

Packing.—Place no undissolved salt in the bottom of the

* We have known those who would not work the brine out of the butter "because," say they, "it will weigh less;" mistaken shrewdness, to gain a penny they lose a pound. That it is necessary to leave brine in the buttor to "keep it" is a great mistake.

tub or pail, unless covered with a cloth so the butter cannot come in contact with it. If this caution is not observed when sold, four or five pounds of butter is thus rendered comparatively worthless. Never pack a poor "churning" with the good butter, thinking it will not be found out. The sale of many a good firkin of butter is spoiled by a few pounds of poor butter becoming rancid in the centre or bottom, which taints the whole package. If there is any butter that is even suspicious, put it by itself.

Select neat pails, tubs, or firkins made of white oak, and cleanse them by placing in each about a pound of the common bicarbonate of soda, and then filling with boiling water, letting the water remain for twenty-four hours. Great care should be used in cleansing pails that are to be re-filled,* as they are usually bedaubed to a greater or less extent with rancid butter. A neglect of this precaution will often cause great loss. Butter until the first of June should be packed in pails or tubs and shipped as soon as made. This butter will keep sweet only a short time. As soon as the weather becomes too warm to ship without risk, pack in firkins, being careful to exclude the air as far as possible while packing. When the firkin is filled to within an inch of the top, dissolve two tablespoonfuls of white coffee sugar, and a piece of saltpetre about the size of a common bean, in sufficient strong brine to cover the butter and

* Pails or tubs after being once used, if properly cleansed, are preferable to new ones.

exclude the air. Place it in a cool dry cellar, and do not disturb it until ready to be shipped. In the fall the butter should be packed in pails or tubs and sold as fresh butter. An air-tight butter pail or tub is very desirable for shipping spring and fall butter.

Test of good butter.—Good butter should have a granular, waxy consistency, and a rich yellow color, except in the winter and spring, when the color is of a pale yellow or nearly white. When cut it should not soil the polished blade of the knife, and the cut surfaces should be free from a dewy appearance. The taste and smell should be entirely free from the slightest trace of rancidity, for if not, however good otherwise, when exposed to the air for a few days it will become almost worthless. The flavor of butter is various, generally depending upon the season, the water, the food of the cows, &c. The preference is merely a matter of choice. If butter upon being cut or repacked is covered with small drops of milky brine, it shows that it has not been sufficiently washed and worked, and although sweet it will not remain so if exposed to the air. When opened for use it should be immediately covered with a strong brine. When it is sticky or greasy, it shows that it was too warm while being churned and worked, or has been overheated since. Such butter is rancid, or will become so as soon as opened.

Setting-pan.—To insure a perfect separation of the cream from the milk a setting-pan has been successfully used in

England. It consists of a large tin pan about four inches deep, holding from four to six pails of milk. It may either set on a table or float in a reservoir of running spring water. Where running water is not to be had, the proper temperature may be obtained by the dripping of melting ice. At one end is a tube covered with a fine strainer to prevent the escape of the cream, through which the milk is to be drawn off, leaving the cream in the pan. All the cream may be secured by rinsing the pan in a little warm water.

The Cheese Dairy.—The superiority of factory cheese is entirely due to the great care exercised in its manufacture. But little cheese is now made by private dairies, for it can be better and more economically manufactured at the factory. With proper management it is more profitable for those who do not live near a cheese factory to make butter, unless they provide themselves with all the necessary apparatus.

Rich Cheese.—The richness of cheese varies in proportion to the amount of the butter that remains entangled in the curd. The following brief directions are from a practical cheesemaker:—

"When two milkings are united, strain the evening's milk and cool by means of pieces of ice dropped into the pails before straining. In the morning take off all the cream, mix it with twice the quantity of new milk. Add warm water enough to raise it to the temperature of 98°. Rub annatto through a silk cloth sufficient to make the curd the color of rich cream. Into this put rennet sufficient to curd in 35 minutes. Stir the whole into the milk previously raised to the temperature of 85°. The milk should be warmed by means of a pail of hot water set into it, but never by putting it over the fire, for the least burning of the milk will spoil the cheese. While the curd is setting, cover with a cloth to prevent the surface from cooling. The method of cutting, scalding, and pressing depends upon the varieties of cheese to be manufactured. About $\frac{1}{4}$ of a pound of the best Ashton salt is sufficient for 20 lbs. of curd. Care should be taken that the whey be entirely expressed."

The different varieties of cheese come to market under the names of Chedder, Cheshire, and Gloucester. These are English cheese. The Dunlop cheese is from Scotland. The Dutch cheese is made in the north of Holland. The Parmesan cheese is made in Italy. Factory cheese is the best manufactured in this country, some of it being equal to the English. The private dairy cheese is of every grade and quality, from the richest Chedder to that made of skim-milk.

Thermometer.—In the butter and cheese dairy the thermometer should be a constant companion. Those who trust to sensations are not aware how easily they may be deceived. Let a person put one hand in cold water, the other into warm, then both into another vessel, and it will *feel* warm to one hand and cold to the other. The only certain guide is the thermometer; its cost is but a trifle, it will save many dollars annually.

Ice-house.—Next in importance to the thermometer is the ice-house. Many farmers say "I can't afford it." They should say "I can't afford to be without it." It will save three times its cost every year. The method of building the following is so simple, and involves so trifling an expense that no man need have an excuse.

Select a place on the north side of some building; lay a floor twelve feet square on scantlings, one foot from the ground. Set firmly in the ground, near each corner, two posts, from four to six inches square, and about eight or ten feet long. When the weather becomes cold, place on the floor saw-dust, tan-bark, or rye-straw, to the depth of eight or ten inches. On the top, place another floor of the same size, putting a curb *inside* the posts to keep the filling between the floors in its place. Next make a curb ten feet square and six inches deep, and fasten the corners with common gate-hooks. On a cold day place the curb on the centre of the floor, put in two inches of tan-bark, and dash water over the bottom until it forms a coat of ice that will not leak. Fill the curb with water and let it stand until frozen solid. With boiling water thaw the curb loose, raise it to the top of the frozen mass, fill and freeze as before. Continue so doing until the mass is of the desired height. Place boards on the *inside* of the posts, and fill the space with tan-bark or rye-straw; nail boards on the *outside* of the posts and fill the space with rye-straw; cover the top with tan-bark to the depth of ten inches. Over the whole put a roof, to shield from the sun and rain. Cut and take the ice from the top. Ice can be thus kept the entire season. If a stream of running water can be turned into the curb, the labor of filling will be much lessened.

SOILING CATTLE.

This is a rather unmeaning expression, and its origin is no more clear than is the fitness of its application; still it has come into such general use that it is now too late to change it.

It is applied to the feeding of cattle in yards or in stables, with grass or other green fodder, cut and hauled to them.

This practice is very rapidly growing in favor in all localities where land is very high priced, where manure is largely used, where the finer class of animals are kept, and where for any reason it is desired to keep a large stock on a small place. It is the best foundation of what is called *High Farming.*

It has been found by experiment that if a field bearing luxuriant grass or clover is divided into two equal parts, one half being used as pasture and the crop of the other being cut and fed in the stable as often as it grows to a sufficient height, this latter half will support, for the same time, four times as many animals of equal weight as will the depastured portion; and while the usual allowance of pasture land is at the rate of two acres for each cow, the allowance of land in soiling, where the system is practised in the best manner, is at the rate of only one-half of an acre for each cow.

Of course, this would not hold good on ordinary land which had been in no way prepared for the practice, but after one or two years' preparation by judicious use of the manure made by the animals fed, and by the aid of proper management, any fair land will support, on the system of soiling, four times as much stock as if they grazed upon it constantly and voided upon it all of their manure.

It was for a long time questioned, and very naturally too, whether cattle would remain in good health if they were deprived of the exercise which they necessarily take in getting their own food in the fields; but ample experience has proved that, if they are allowed good yards in which to exercise for a short time, once or twice a day, they keep in better condition and are less liable to disease than when they are exposed to the various changes of the weather in the fields.

It is also sometimes objected that this treatment is an unnatural or an artificial one. To this the reply is that our domestic animals are artificial productions. In nature we see no working oxen, and no cows give during the whole year a tenth part of the quantity of milk that cows have been forced to give in a state of domestication.

With the writer, the soiling of cattle is not a matter of theory. He has adopted the system on his own farm, and has sufficient evidence in his own practice of its substantial advantages.

Perhaps the most practical way to give an idea of the manner in which stock is managed under the soiling system will be to describe the operations as there carried out.*

The farm† comprises sixty acres, lying in a nearly square body, and *all in one field.* Adjoining the main farm there is a small field in which to pasture calves during their first summer only, but it is not intended that the older animals shall ever feed except in their stalls.

In the centre of the farm there is an enclosure of about four acres, within which are concentrated all of the farm buildings; outside of this there is nothing to interfere with cultivation—no interior fences, rocks, nor trees.

The barn-yards occupy two acres of what was formerly an apple-orchard, and in the middle of this stands the barn (40 ft. × 100 ft.). This has a cellar under the whole for the accumulation of manure, and (one corner of it) for the storage of roots. The main floor—the whole extent of the building—is occupied by two rows of stalls, the animals facing a central passage-way, through the entire length of which there runs a railway with a car, for distributing the food. The next floor above is used for the storage of hay and grain and of implements, and for the cutting and steaming of food in winter. Each floor and the cellar can be entered by loaded teams.

On the cattle floor there is a system of water-troughs which are constantly supplied from a tank on the floor

* To make this description more complete, a few improvements which are contemplated for the coming year are spoken of as though now in operation.

† Ogden Farm, Newport, R. I.

above, which is filled by a wind-mill, from a running spring. By this means water is always kept within reach every animal.

The floor is divided into four principal parts, separated from each other by bars which run (one on each side of the barn) from the rear of the stalls to the wall; and each of these divisions has its own door, communicating with a yard nearly half an acre in size, surrounded by a four-foot stone wall, and sufficiently shaded by the remains of the former orchard. Each set of animals has its own quarters and its own ample exercising ground, so that all danger from over-crowding is avoided.

They are turned out for exercise in pleasant weather at 8 A.M. and at 2 P.M., and are kept out (by closing the doors) for about two hours each time. If the doors are left open they return to their stalls almost immediately. Being abundantly fed, they show no disposition to move about, and I am satisfied that they give more milk and keep in better condition than if they were allowed the best pasture without shelter, even in the summer time.

Five times a day they are given as much green fodder as they will eat. This is cut in the field, loaded on to a cart, and hauled to the upper floor of the barn, where it is dumped through a trap-door into the car, by which it is carried to the stalls. The manure is dropped through an open slat-floor, and through scuttles, into the cellar, whence it is drawn in wagons directly to the field, having been well worked over by hogs while in the cellar. Thus it will be seen that the labor of attending to a large stock of cattle is reduced to the lowest possible amount.

ARRANGEMENT OF CROPS FOR SOILING.

The amount of land that it is necessary to appropriate for the supply of fodder for each animal must, of course, depend on the quality of the land and on the degree to which its productiveness is forced.

Under all ordinary circumstances, one-half acre of land, in good heart and in good tilth, should be allowed for each full-grown milch cow of the ordinary breeds (more for short-horns), but, under high cultivation, this will allow a considerable amount of the produce to be cut for winter use.

The regular soiling crops are the following :—

Winter Rye,
Cabbages,
Oats,
Clover,
Grass, and
Indian corn.

Many other crops are available, such as Hungarian grass or millet, wheat, Jerusalem artichoke, sainfoin, &c., but the foregoing are the regular dependence of American farmers, and are the best for common use.

The best essay that has yet been written in this country on the subject of "soiling" was prepared for the Massachusetts Agricultural Society by the Hon. Josiah Quincy, and was published in the Journal of that Society for 1820.

His recommendation is as follows:—

"1. As early in April as the state of the land will permit, which is usually between the 5th and the 10th, on properly prepared land, sow oats at the rate of four bushels to the acre.

"2. About the 20th of the same month, sow oats or barley, at the same rate per acre, in like quantity and proportions.

"3. Early in May, sow, in like manner, either of the above grains.

"4. Between the 10th and the 15th of May, sow Indian corn (the flat Southern being the best) in drills, three bushels to the acre, in like quantity and proportions.

"5. About the 25th of May sow corn in like quantity and proportions.

"6. About the 5th of June repeat the sowing of corn.

"7. After the last-mentioned sowing, barley should be sown in the above-mentioned quantity and proportions, in succession, on the 15th and 25th of June, and on the 1st of, or early in July; barley being the best qualified to resist the early frosts."

Mr. Quincy depended on the mowing of the best of his grass land to carry his stock through the month of June, or from the earliest pasturing season to the 1st of July, when he expected his first sowing of oats to be ready for the scythe. After the first killing frost, he depended on the tops of about twelve acres of root crops, for the use of fifteen cows.

The plan which I have adopted is a modification of the above, and is as follows (for twelve cows):—

1. Early in the autumn sow three acres of winter rye, to be cut from May 15th to June 15th.

2. Early in April, three acres oats, to be cut from June 15th to July 1st.

3. Late in April, two acres oats or barley, to be cut from July 1st to July 15th.

4. Early in May, two acres oats or barley, to be cut from July 15th to August 10th.

5. Middle of May, two acres corn, to be cut from August 10th to September 1st.

6. Middle of June, the three acres from which rye has been cut to be sown with corn, to be cut from September 1st until September 20th.

7. Early in July, the first three acres sown with oats to be resown with barley, to be cut from September 20th until the harvest of roots and cabbages furnishes a stock of green refuse, which will suffice until winter feeding commences.

This is an allowance of twelve acres for twelve cows, and assumes that the latter end of the season will be helped out by root tops, &c. The reason for appropriating so much land is that the soil is not yet in sufficiently good condition to *insure* an ample supply from a much smaller area. In a season of extraordinary drought the whole of the product may be consumed, but in any ordinary year a very large part of it would be in excess, to be cured and stored for winter use, and to furnish a supply of dry food, with which occasionally to alternate with the fresh fodder, to prevent the too great relaxation of the bowels which a free use of succulent food sometimes causes.

In September three acres of the four comprising Nos. 4 and 5 should be sown with winter rye for the following spring's use, and the rotation should follow in regular order. If all of the manure made in the soiling season were to be used on these twelve acres year after year, I am satisfied that they might be made in time to support, during the whole of the usual pasturing season, thirty milch cows, or five cows for each two acres.

In my own case, as one of my reasons for adopting the system of soiling has been that it is the best help in bringing up a worn-out farm, I shall each year raise my forage on fresh land, so as to give the whole place the benefit of the treatment.

Of course, a rule which will apply in one region may not be the best for another, and each farmer must decide for himself the extent to which he can profitably adopt the system on his farm, and also what crops will best accomplish the desired end in his own case.

Where it is desirable to plough as little as possible, clover and grass may with advantage enter much more largely into the arrangement.

Two general principles, however, may be stated as applicable to all of the more temperate regions of our Northern States—

1. The *earliest* abundant food will be secured by the use of winter ryc.

2. The *best* and most abundant food for the later summer and earlier autumn time will be secured by the use of Indian corn.

ARGUMENTS IN FAVOR OF SOILING.

Mr. Quincy states the following as the leading advantages of this system:—

"1st. The saving of land.

"2d. The saving of fencing.

"3d. The economizing of food.

"4th. The better condition and greater comfort of the cattle.

"5th. The greater product of milk.

"6th. The attainment of manure."

On the subject of the 3d item—the economy of food—he says: "There are six ways by which beasts destroy the article destined for their food—1. By eating; 2. By walking; 3. By dunging; 4. By staling; 5. By lying down; 6. By breathing on it. Of these six, the first only is useful. All the others are wasteful."

The other points he elucidates with equal force, but at too great length for full quotation here.

The statement made above that a milch cow may be kept during the ordinary pasturing season upon the produce of one-half acre of land, while of land of the same character at least two acres would be necessary on the pasturage system, is sufficient to illustrate the saving of land. Yet this statement, which will be supported by the testimony of all who practise the system on land of good quality, is far below the estimate of many who have had a lifelong experience of soiling in Europe. Some of them place the proportion in favor of soiling as high as 1 to 7. Of course the amount of stock which may be fed from the produce of a single acre depends very much on the manner in which that acre is cultivated, and the question of the cost of labor must determine whether it is or is not profitable to force the production beyond a given extent.

As to fencing, it is only necessary to remind nearly every farmer of his own experience of the first cost of building, and of the yearly cost of repairing the fences of his own farm, and to say that by the soiling system, when completely carried out, *all interior fences may and should be entirely dispensed with.*

Add to the question of expense, the fact that useless headlands and their nurseries of noxious weeds are got rid of, and that the plough can be driven, if desired, straight through from one side of the farm to the other, and the argument needs no re-enforcement.

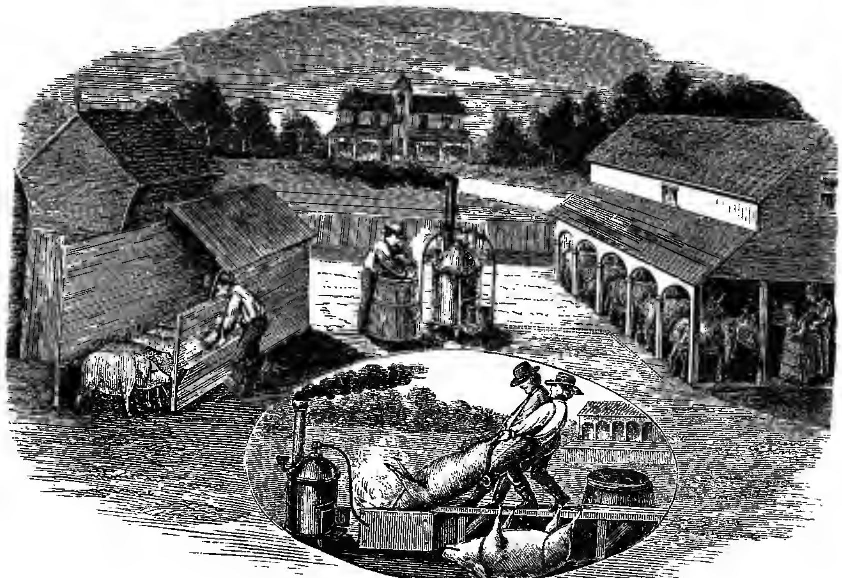
Concerning the condition of the cattle, the following is stated by Quincy:—"One writer asserts that he has kept a large herd for several years in this way, and during the whole time 'he never had an animal essentially sick, had never one die, and had never one miscarry.'" The general result of the experience of hundreds of farmers in Europe, and of considerable experience in America, is, that cattle are really better off in every way, under the protection of the soiling barn, with its ample and regularly supplied food, and with the advantage of daily currying and exercise, than when left to shift for themselves exposed to the vicissitudes of the weather.

The quantity of milk may never be so large as it is during the flush weeks of June, when the cows are gorging their maiden appetites on rich grass; but the consumption of food from the first of May to the first of November (and *consequently* the yield of milk) will be much greater.

"Last, but by no means the least," the question of manure asserts its claim to the fullest consideration. Were it not for this item of the calculation the arguments in favor of soiling would lose more than half their force.

The immense superiority, both in quality and evenness of distribution over the soil, of manure which is made and kept under cover, over that which is dropped at random on pasture fields; and the advantage of being able to apply it when we please, where we please, and in such quantities as we please, are too well known to all who have to use manure to produce paying crops, for any argument on the subject to be necessary. There is no way in which so much manure of such excellent quality can be landed on the farm without a far greater outlay of money than is necessary to pay for all the labor required for ploughing, sowing, "tending," cutting, and hauling the food, and for currying and feeding the animals under the most complete soiling management.

Of course the manure argument does not hold (nor is the system of soiling to be recommended) for those districts of the West where the laughing harvest follows the tickling hoe; where straw is burned in the fields, and barns are moved to get away from the accumulated manure. But for the older settled countries of the East and South (and for the future West—the West with its "inexhaustible fertility" exhausted) it does hold, and with such force that as population grows more dense—and farmers more wise—it alone, even if there were no other advantage in the system, must in time compel the rapid increase of the practice of soiling.



APPARATUS FOR STEAMING FOOD, &c.

STEAMING FOOD FOR STOCK.

A more recent improvement than "soiling" in the keeping of cattle, on farms where it is important to make every pound of food tell with the fullest effect in the production of meat, muscle, or milk (and on what farm is this not important?), is the *steaming of food* in winter.

Although this practice has been the subject of much less experiment than soiling, and is, consequently, less generally recognized as worthy of adoption, enough is known of its advantages, both by experience and from theory, to make its brief discussion necessary to the completeness of this book.

During the past year I have investigated the subject with some thoroughness, and have determined to adopt it on my own farm; and I can hardly do better than to give here some account of my investigations, in order that my readers may decide for themselves the soundness of my reasons for the determination.

My serious attention was first called to the matter by an article in the Report of the Department of Agriculture for 1865, written by Mr. E. W. Stewart of North Evans, N. Y. He therein details his own experience of ten years in steaming food for a large stock of cattle and horses, gives a succinct statement of the reasons why steaming is beneficial, and sustains his own opinion by the concurrent testimony of other practical farmers who have found the practice beneficial.

The following are the results of the operation as stated by Mr. Stewart:—

"1. It renders mouldy hay, straw, and corn-stalks perfectly sweet and palatable. Animals seem to relish straw taken from a stack which has been wet and badly damaged for ordinary use; and even in any condition, except 'dry rot,' steaming will restore its sweetness. When keeping a large stock, we have often purchased stacks of straw which would have been worthless for feeding in the ordinary way, and have been able to detect no difference, after steaming, in the smell or the relish with which it was eaten.

"2. It diffuses the odor of the bran, corn-meal, oil-meal, carrots, or whatever is mixed with the feed, through the whole mass; and thus it may cheaply be flavored to suit the animal.

"3. It softens the tough fibre of the dry corn-stalk, rye-straw, and other hard material, rendering it almost like green succulent food, and easily masticated and digested by the animal.

"4. It renders beans and peas agreeable food to horses, as well as other animals, and thus enables the feeder to combine more nitrogenous food in the diet of his animals.

"5. It enables the feeder to turn everything raised into food for his stock, without lessening the value of his manure. Indeed, the manure made from steamed food decomposes more readily, and is therefore more valuable than when used in a fresh state. Manure made from steamed food is always ready for use, and is regarded by those who have used it as much more valuable, for the same bulk, than that made from uncooked food.

"6. We have found it to cure incipient heaves in horses; and horses having a cough for several months at pasture, have been cured in two weeks on steamed food. It has a remarkable effect on horses with a sudden cold and in constipation. Horses fed upon it seem much less liable to disease; in fact, in this respect, it seems to have all the good qualities of grass, the natural food of animals.

"7. It produces a marked difference in the appearance of the animal, at once causing the coat to become smooth and of brighter color—regulates the digestion, makes the animal more contented and satisfied, enables fattening stock to eat their food with less labor (and consequently requires less to keep up the animal heat), gives working animals time to eat all that is necessary for them in the intervals of labor; and this is of much importance, especially with horses. It also enables the feeder to fatten animals in one-third less time.

"8. It saves at least one-third of the food. We have found two bushels of cut and cooked hay to satisfy cows as well as three bushels of uncooked hay, and the manure in the case of the uncooked hay contained much more fibrous matter unutilized by the animal. This is more particularly the case with horses."

Other publications on the subject fully confirm Mr. Stewart's estimate, and we commend his essay, which is accessible to all, to the careful attention of every feeder of farm stock.

In January (1868) I visited the farm of Messrs. S. & D. Wells, at Wethersfield, Conn., for the purpose of examining their cow stable and its fixtures.

The leading features of this establishment are a constant water-supply, and apparatus for cutting and steaming food.* The latter was introduced at a cost of about $500. It comprises a three-horse steam-engine of very simple construction, a tubular boiler of sufficient capacity to run the engine, a strong *power* stalk-cutter, and a chest for steaming food.

There were about thirty cows in the stable. They receive steamed food morning and night, and dry hay at noon. The steamed food consists of hay of poor quality, straw, or cornstalks, cut to short lengths, sprinkled until thoroughly wet, and then dusted with bran or meal, and steamed for about two hours.

The engine has power enough to cut in a couple of hours

* The water is brought from a living spring and flows through galvanized iron pipes which form the connections between the bottoms of small iron troughs standing at the head of the partitions which divide each pair of stalls. The last trough overflows through a pipe near its top, and the water wells up to the level of this overflow in each trough of the series. By this simple arrangement, a constantly changing supply of water is kept always in front of the cattle.

a supply sufficient for the whole week, and enough is steamed at one charge to last for three or four days. Steam is made only twice in each week (once for cutting and steaming, and once for steaming only), and then only for a short time.

The steaming box is about four feet square and eight feet high. The materials are put into the box from the floor above that of which the cow stable is an extension, and are removed through a door in one of its sides on the feeding floor. Elevated a short distance above the bottom, there is a false bottom perforated with many holes. The steam is let in below this, and is thus allowed to rise evenly through the the whole mass.

The box is made of two thicknesses of one-inch, matched spruce boards (one set running up and down, and the other across). The doors are not made with any very great care to prevent the escape of steam, nor does it seem to be considered necessary to do more than to have the box strong enough to hold its burden of wet fodder.

The Messrs. Wells find that Mr. Stewart's opinion—given above—is, in all essential particulars, sustained by the results of their experience. They think that steaming adds one-half to the feeding value of fodder.

It was what I saw on their farm, more than anything else, which caused me to decide on adopting the system in my own practice. My apparatus is not yet completed, and I cannot, therefore, speak on the subject with the authority of a successful experimenter; but from all that I can learn, I am satisfied that the advantages of steaming have hardly been overrated.

The theory of the process (in a nutshell) is this: Cattle and horses in a state of nature live the year round on succulent green herbage. When the cold weather begins to cut short the supply in the more northern latitudes, they migrate toward the south. Man steps in and keeps them in the colder climate. He substitutes dried grass for fresh grass. Steaming will, in a great measure, restore hay to the condition of green grass. Also, many constituents of hay, straw, &c., are insoluble and indigestible. By the action of heat and moisture they become soluble, or at least are reduced to a condition in which they are easily available to the digestive organs of animals. Starch-grains, according to the best authorities, are coated with a layer or cuticle which resists —to a great extent—the action of the juices of the stomach, while its interior parts, could they be directly exposed, would readily be assimilated; therefore, as heat causes the interior of the grains to swell and burst their coating, exposing themselves on the surface, as the interior parts of a kernel of corn do in "popping," the process of steaming (or any cooking) makes the starchy part of food more readily available.

Examinations of the droppings of animals fed on cooked and uncooked food furnish results which confirm the foregoing opinion.

Carefully conducted experiments on animals of equal weight, and of like condition in all respects, invariably show that those which are fed on cooked food take on fat, and form bone and muscle more rapidly than those which get only raw food. If, after a certain time, the food is changed —the cooked being given to the animal that has been receiving the uncooked, and *vice versa*—the rapidity of growth will change too. The trial has often been made, and the result has been invariably the same.

In fact, in all of the essays and opinions on the subject of cooking food for domestic animals, in this country and in Europe, I have failed to find the first one that is not decidedly favorable.

Steaming, of course, is valuable only because it is a means of *cooking*, and the arguments in its favor bear equally on the subject of *boiling*. *Steaming* is rapidly coming into use because of its greater convenience and economy.

How to make a Steaming Apparatus.—Any device by which steam may be generated under a very slight pressure —barely sufficient to cause it to penetrate the mass to be cooked—and conducted to the vessel in which the steaming is to be done, will accomplish the desired purpose; but, of course, the more convenient the arrangement, and the less the waste of steam (whether by condensation or otherwise), the more economically the process may be performed, as to both time and fuel.

Mr. Stewart suggests a plan which, from its cheapness, will answer a good purpose where the stock to be cooked for is small, or where it is desired to experiment on a small scale.

It is a box made of well jointed 2-inch pine, seven or eight feet long, and about two and a half feet wide, with a bottom of No. 16 sheet iron, nailed securely on to the lower edge of the sides and ends, and turned up a little outside of them—say half an inch. This box has a false bottom, of wood or iron, placed about three inches above the fast bottom, and perforated with many small holes, and a closely-fitting cover over the top.

It stands on brick walls which do not come quite so far out as the wooden sides of the box. At one end of the chamber enclosed by these walls there is a wood fire-place, and from the other end a chimney rises.

The space between the bottom and the false bottom is partly filled with water, cut hay mixed with meal or bran is put in the box above the false bottom, the cover is closed, and the fire is started. The steam rises through the perforations in the false bottom, and cooks the mass above it.

A much more complete apparatus for steaming, and in large practice a more economical one, comprises a boiler for generating the steam, a box in which to place the food, and a wooden, or well protected steam-pipe to connect the two. The box should have a perforated false bottom, and the steam should be introduced beneath this, so that it may diffuse itself uniformly through the mass.

The boiler may, of course, be of any pattern that will secure the economical generation of steam. A discarded engine-boiler will answer every purpose if it is strong enough to bear a pressure of, say, five or ten pounds to the inch—a slight pressure being necessary to force the steam through the mass of hay.

D. R. Prindle's Agricultural Boiler, which is shown in the accompanying cut, is admirably adapted for this use.

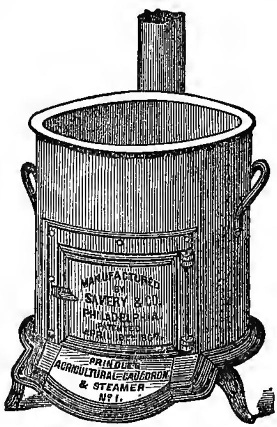


Fig. 1.

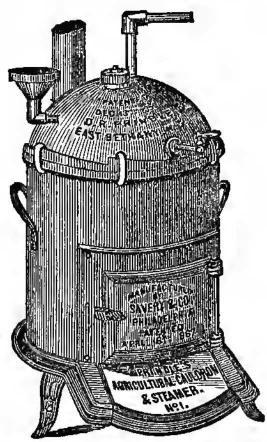


Fig. 2.

Prindle's Agricultural Steamer and Cauldron (shown in Figs. 1 and 2) is the invention of Mr. D. R. Prindle, of East Bethany, New York, and is largely manufactured by Messrs. Savery & Co. of Philadelphia.

Its popularity seems to be rapidly increasing, and there is no question that it is the best steaming apparatus for the use of all farmers who do not employ steam-engines that has yet been invented.

It consists of a cauldron set over a furnace arranged to burn either wood or coal, and furnished with a dome which fits closely over it and is keyed down so as to make a steam-joint It is provided with a test-cock to show when it needs the addition of water, a safety-valve which is also a *vacuum* valve, a funnel for filling, and one or more pipes to convey the steam to the cooking-boxes.

Aside from its use in steaming fodder for cattle, it may be used to heat water to scald hogs, or for other purposes, to warm buildings, to cook roots or meal for hogs or grain for fowls, and for a variety of other purposes for which hot air, hot water, or steam are useful.

For farm use, especially when constant steam is not required, Prindle's steamer is much better than an engine-boiler, as it works only at a very low pressure, and is consequently quite safe, and is much cheaper when we consider the cost of setting up the larger engine-boiler, and its more expensive transportation.

Full particulars concerning the Prindle steamer may be obtained by application to the inventor.

I have not determined, in my own case, what power to adopt for the cutting of my long fodder. The question is about evenly balanced between a small steam-engine, a wind-mill, and a railway horse-power, for final use; but as the first cost will be less, I shall commence with the horse-power belonging to a threshing machine, and a Prindle boiler, changing to one, the engine or mill, at a future day, if it seems desirable.

It is hardly prudent to make any positive calculations in advance of actual experiment, but I anticipate—and I base my calculations on a very careful survey of the whole field —a saving of about *forty per cent.* in the cost of feeding my stock, over the present system of feeding only the best hay uncut. A part of the saving will be due to the more digestible condition of the food, and a part to the fact that a much cheaper quality of hay, or straw, or corn-stalks can be largely used. A saving of very much less than this, when from thirty to forty head are to be provided for, will be enough to make a fair profit on the business.

The various uses for which steam can be adapted seems to be but little understood by the masses. Fear of explosions, scalding, &c., as well as want of knowledge of its great advantages, has thus far prevented its general introduction.

The want of a perfectly safe and easily managed low pressure apparatus with which to accomplish all the requirements of domestic use, has also been a great drawback. The great advantages of cooking, heating, boiling, &c., by steam, are obvious when it is remembered that it can be done with much less water and fuel, requiring but little care of the operator, and using wooden vessels (if desired) of any kind, size, or shape (a great desideratum). By its use there is no re-filling of *kettles* (the ordinary mode) to get a desired quantity; no constant watching or stirring, or removal of the substance while hot, to prevent burning; no cleaning of kettles for every separate job, which can be done by steam. By the use of this powerful agent, large quantities may be boiled or steamed, or several vessels (if need be) treated at the same time; and when desirable, the steam can be conveyed in pipes or logs to some little distance, using proper care in protecting the same from condensation; thus avoiding, many times, danger from fire, and accommodating itself to all the various purposes of domestic economy, as well as in the manufacturing of many articles or compounds, when danger from burning or explosion is so common. By steam the clothes may be boiled at any point in the barrel or tub; the bath-tub may be warmed in an adjoining room; the farm or stock-feeder could easily cook in quantities at a time, or scald his hogs, steam his barrels, &c., &c. We believe that when a cheap, simple, and perfectly safe apparatus is once introduced, that the subject (as it deserves) will receive much more attention, as by steam *all classes* might as easily be benefited.

ADVANTAGES OF COOKED FOOD.

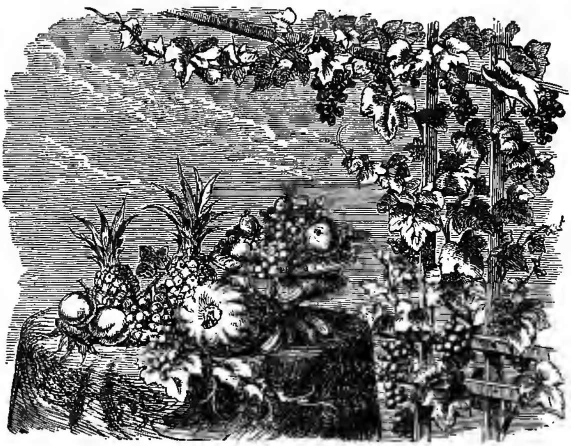
The *American Agriculturist* for January, 1860, says: "Experiments made by C. M. Clay, of Kentucky, showed that one bushel of dry corn made 5 lbs. 10 oz. of pork; of boiled corn, 14 lbs. 7 oz., and boiled meal, 16 to 18 lbs."

Morton's Cyclopædia of Agriculture (than which there is no higher authority in Europe) says: "As to steaming food for cattle, there is abundant experience to recommend it. The process of cooking renders soluble that which would otherwise be imperfectly digested. It removes, in some cases, what would otherwise be unwholesome; and it renders savory what would otherwise be distasteful."

Loudon's Encyclopædia of Agriculture remarks: "Unless food be thoroughly deprived of its vegetative powers before it enters the stomach, the whole nourishment which it is capable of affording cannot be derived from it. The most effectual mode of destroying the living principle is by the *application of heat*, by steaming or boiling."

The *Society of Shakers*, at Lebanon, N. Y., famous for pork-raising, say: "For fattening animals, swine particularly, we consider three of cooked equal to four of raw meal."

GARDENING FOR MARKET.



While market-gardening, as a systematic business, is quite distinct from farming, there is no farmer who lives near a town who may not make the raising of certain crops on a small scale very profitable. Success in this branch of the business of the farmer requires that the land to be devoted to its prosecution he dry, warmly situated, with a good exposure, and *rich* and again *rich.*

The amount of manure which may be *profitably* applied to land intended for the growth of market vegetables has hardly any limit. One hundred cartloads of good horse manure to an acre, *every year*, will pay more *profit* than will fifty loads; and I am inclined to believe that even two hundred loads would pay better still.

The cultivation of vegetables entails, in any case, a heavy outlay for labor, seed, expenses of marketing, &c., and these are about the same (except in the matter of marketing) for a light as for a heavy crop—it takes a certain amount of produce to pay the cost, and up to this point there is *no profit.* Beyond this point, except the cost of the manure, it is nearly all profit, and the more we can stimulate excessive production the more rapidly will the ratio of profits increase over the expenses.

No farmer can hope to become really successful in raising vegetables for market until he is prepared to expend—including the value of the manure used—at least $300 annually on every acre of his garden land. With this outlay, if his soil is good and well placed, and his market is a good one, and *if he is the right man for the business*, he ought to make a clear profit of $500 per acre.

The character of the market should be well understood. If there is a manufacturing town near by, or any town having a population which includes a large proportion of laboring people, the case is a simple one.

It should be well understood that it does not pay (at least so far as gardening is concerned) to feed *the rich.* They are like the black sheep of the flock, that don't eat so much as the white ones—there are not so many of them, and, as another reason, they do not eat so largely of coarse vegetables. A hearty Irish laborer, with a stout hardworking wife and a table full of healthy children, will use up cabbages and turnips in a way to delight the heart of a gardener; and the atmosphere of a manufacturing town will evaporate a farmer's load of these vegetables as the sun dries up the morning mists.

To any one who is disposed to venture an acre or two in gardening, no better service can be done than to recommend him to read Peter Henderson's "Gardening for Profit," wherein are laid down precise rules for the management of every department of the business.

We have here only space to give a few practical hints which will be chiefly of use to *farmers* who propose to devote a portion of their time to the simpler kind of gardening.

It may be given as a general rule, that the only crops that it will pay the *farmer* to raise, in his market garden, are beets, cabbages (early and late), sweet corn, cucumbers, onions (rare-ripes), parsnips, radishes, spinach, and tomatoes.

The size, arrangement, and equipment of the garden.—We will suppose a farmer to be about to embark in this business, and that he is willing to invest in it a capital of one thousand dollars. Of course the same general rules will apply for a more or less extensive operation. He should select two acres of light dry land (if he has it, and if not he should thoroughly underdrain it), if possible with an exposure to the east or south. If it is sheltered from the north and west by an orchard or by other trees, so much the better.

The land may be more economically arranged if it lies in about a square body, and should be fenced on the north and west sides with a tight board fence six or eight feet high. A fence of the latter height, made in the best manner, of pine boards, capped with a spruce rail, will cost in the vicinity of New York about $200 for 600 running feet. This fence should set close to the ground, so that the wind cannot draw under it, and it will have the effect of very materially modifying the climate, and enabling the growing of much earlier vegetables.

Close in the northwest corner he should then set up two parallel rows of hemlock boards, nailed to 2x3 stakes, driven into the ground. The back line of boarding should be 12 inches high, parallel to the fence and three feet distant from it. The other row should be 8 inches high, parallel to and 6 feet and 2 inches distant from the first, outside measurement. Both to be 187 feet long, with boards to close up the ends, and the ground enclosed by them should be spaded and manured. This is the "cold frame," which is to be covered by 50 sashes, each 3 feet 9 inches wide by 6 feet 2½ inches long, having four rows of glass, each containing nine 8x10 lights set lengthwise across the space—the rails being ten inches apart. The sashes to be made of 1¾ inch stuff and strengthened by a flat rod of iron (1 inch by $\frac{3}{16}$ inch) let in flush on the under side and screwed fast to the bars and rails, across the middle of the sash. It is best to make the sashes in the best manner, as they are a very important part of the permanent stock in trade of the garden. They will cost, at an outside price, $250.

The ground of the garden should be deeply ploughed and subsoiled in July or August, and if the weeds that grow upon it are likely to ripen their seeds, they should be mowed down late in the fall. Before winter sets in, the largest amount of horse manure that can be bought for $200, delivered, should be spread upon the surface, and left exposed to the rain and melting snow of the winter.

About the middle of September, sow in a well-prepared seed-bed in an old garden, twelve ounces of the seed of Jersey Wakefield cabbage, and four ounces of Fottler's Improved Brunswick. At about the same time sow on three feet of one end of the cold frame, one ounce of black-seeded butter lettuce, and one ounce of early-curled Simpson lettuce, giving to each about nine square feet. These are to remain where they are sown during the winter. The cabbage plants will be large enough to transplant about six weeks from the time of sowing, when they are to be "pricked out" in the cold frame two inches apart each way, which will give about 800 plants to a sash. These plants should be well watered, and sprinkled with a light coating of air-slaked lime.

They will need to be protected by the glass until they are firmly rooted (the sashes being tilted up at the back to give them air whenever the sun is on them), and on frosty nights, and they should be gradually accustomed to the cold air, so that they may be able to withstand the hard freezing that they will get in the winter; all through the winter they should have air whenever the frost is thawed from the under side of the glass, and on fine days the sashes should be stripped off from them altogether. The end where the lettuce plants are standing should have less air, and should have the protection at night of an old carpet thrown over the sash. Directly in front of the cold frame there should be a second frame made of exactly the same size and character. This should be filled with straw, leaves, or other rubbish which will keep it from freezing, and about the last of February or the first of March its covering should be removed and about three inches of well-rotted manure should be dug into it—not too deeply. The lettuce plants are now to be transplanted to this frame, at distances of six and a-half or seven inches each way (about seventy plants to a sash), and covered by the sashes which may now be taken entirely from the hardened cabbage plants. If light board shutters have been provided to cover the cabbages during severe storms, it will be better, but they will stand any amount of hardship after their winter's training. The lettuce plants should have plenty of air during fine weather (and some air whenever it is not freezing), should be abundantly watered if the season is dry, and should be forced by as much heat as can be given them without depriving them of air. They will be ready for market about the middle of May, when lettuce usually sells in towns (not in the larger cities) for from 8c. to 12c. per head.

During the latter part of April, plant sixty three-inch pots with half a dozen seeds each of White Spine cucumber, and set them in a warm light room in the house. By the time the lettuce is sold off these will be sturdy plants, and they should be thinned to three in each pot. Now dig holes a foot deep, and a foot in diameter, at intervals of three feet in the lettuce frame, and fill them with very thoroughly rotted and rich compost, covering it with a little soil. On each of these plant the contents of a pot, without disturbing the roots of the plants, and cover closely with the sashes. Give a little air in the middle of the day, but cover close from 4 P.M. until 10 A.M., and during all chilly weather; water copiously, and uncover to all warm rains.

By the latter part of June the picking will commence (at from 5c. to 30c. each), and it may be continued as long as the price is not less than 1c. each. This crop is more uncertain and varying in its results than lettuce, but it usually pays well, and is very inexpensive.

Now let us sum up the probable income of 50 sashes, managed as directed above:—

35,000 cabbage plants, at $10	$350
3,500 lettuces, at 8c.....................	280
Cucumbers (from $25 to $100), say........	50
	$680

This is earned with a small investment, and the labor is mainly done in the fall and winter, when other work is slack; and it has the great advantage of coming in early, when there is a demand for ready money to pay for labor, &c.

Five hundred tomato plants may be started in the kitchen window, or in a small hot-bed, and by the middle of April they may be pricked out in one end of the lettuce frame. As early in May as the danger of frosts has passed, they should be set out at intervals of fifteen inches along the foot of the fence on the north and west sides of the field, to be trained up against it (tacked fast), and kept trimmed to single stems. At a height of six feet they should be pinched off and their growth kept close. They should be planted in a very rich soil, and well watered. They can hardly fail to produce early crops, and ought to sell for $75 to $100.

Now we come to the management of the field crops.

If we could only raise cabbages year after year on the same land, our business would be a very simple one. We might take two crops yearly (an early and a late one) of the most profitable and easily raised vegetable on our list.

But, unfortunately, one crop in two years is all we can reasonably hope for, as the "club-foot" will surely attack an immediately succeeding crop on the same ground, and our best plan is to arrange to grow as many cabbages as we safely can—making this point our constant aim—and to occupy the land as profitably as possible the rest of the time.

Therefore, the field should be divided into two equal parts, one side being prepared for cabbages and the other for such other crops as will not interfere with the growth of cabbages the next year.

The first operation is the preparation of the ground for early cabbages, for which we devote a space of about one acre.

The manure which was spread in the fall should be lightly ploughed in—not deep enough to turn up the old sod—and a thousand pounds of Peruvian guano, two thousand pounds of fish guano, or fifteen hundred pounds of bone-dust, should be evenly sown over the ground, and thoroughly harrowed in. Either of these manures will cost about $40. As early as it is possible to get the ground into proper condition, as described above, the cabbage plants in the cold frame should be set out, in rows two feet apart, and about 16 inches apart in the rows. It will probably be best to plant three-fourths of the piece with the Jersey Wakefield, and the remainder with the Brunswick, which will begin to be fit for market at about the time when the Wakefield is all sold.

This amount of land will receive about 15,000 plants, leaving about 20,000 plants to be sold from the frame. If the value of cold frame plants is understood in the vicinity, they will be readily taken up at $10 per thousand.

If there is a good summer market for lettuce, the Early Curled Simpson may be set out between the rows of cabbage, when it will grow to a marketable size before the whole ground will be required by the main crop. In the neighborhood of small towns this will not be worth while, as there is but little demand for lettuce after June 1st.

As soon as the cabbages are planted—and this may be done even so early as in March, if the weather is fine—the other half of the garden should be manured and prepared in the same manner, and planted with beets, onions, parsnips, spinach, and radishes; the first four in about equal proportions, and in the following manner:—

Beets (of the Bassano and the early turnip-rooted blood variety) should be very thickly planted in rows 18 inches apart—thickly, because the early frosts may cut off a part of the crop—and when they are fairly up, they should be singled out to intervals of about 4 inches in the rows.

The *onions* should be "sets" raised the previous year. These may usually be bought for from $6 to $10 per bushel, according to size—the smallest bearing the highest price. They should be set in rows 9 inches apart, and at intervals of 3 inches in the rows, being firmly pressed down in the bottom of the line made by the marker. Every seventh row should be omitted to leave room to walk among the crop, and the sets should be entirely covered by raking the beds evenly over.

Onions raised from the seed are rather a farm than a garden crop, and will not pay to raise on land so expensively manured as that under consideration.

Onions raised from "sets" are called *Rare Ripes*, and they always meet a ready sale in any market where there is a market for any vegetables. Still, as it is considerable work to tie them, it will be best not to raise more than one-quarter of an acre of them.

Parsnips should be planted early in May on well prepared (deeply loosened) ground, in rows 27 inches apart, the seed being strewn thickly in the rows, and the plants finally thinned to intervals of six inches. The reason for putting the rows so wide asunder is that it enables us to cultivate the crop with the horse-hoe at a time when labor can be ill spared for hand-hoeing.

Spinach.—This crop, the first year, must be planted in the spring; by planting very early, on ground so heavily manured, it will be in market ahead of green peas, and will bring a good price, but after these are plenty it can hardly be sold at any price. The cultivation of this crop is extremely simple. The seeds are sown pretty thickly (say 10 lbs. per acre) in rows about 12 or 14 inches apart, and the land kept clean until it is large enough to cut.

For all subsequent years, spinach should be planted about September 15th, on the ground from which the Brunswick cabbage has been taken, this being first well manured with animal manure. It will require (above the latitude of New York) a light covering of seaweed, leaves, or straw during winter. Coming very early into market, it often brings *four dollars a barrel.*

Radishes are a stolen crop, and, to a limited extent, they may be very profitably grown. It is best to raise both the long scarlet and the short top turnip-rooted varieties—the former for common trade, and the latter for those who are more choice in their taste, the proportion of each being regulated according to the character of the market.

The seed may be sown, rather thinly, with a seed drill between the rows of beets. No cultivation is needed. The seed is the only cost except the preparation for market, and this need be applied only to so much as there is a sale for; the rest can be simply cut out with a push hoe, before the beets will require the whole ground.

We have now provided for the planting of all the land, and will need to commence promptly to use the hoes, of which at least two should be kept going incessantly until the crops are all firmly established, and are able to hold their own against weeds. In fact, at no time during the growth of the crops, until they are too large to be worked among without injury, should weeds be allowed to grow *at all.* If they once get started so that there must be a fight to get rid of them, we may as well say good-bye to all hope of profit, for they will require more labor than it will be pleasant to pay for, and the crops will be materially injured by them. If, on the other hand, every foot of the land be lightly hoed over (or even raked with a light iron rake until it becomes too hard) once a week, there will be no weeds to kill, and the plants themselves will be sufficiently benefited by the operation to pay the cost.

Harvesting the crops, and preparing them for market.

The first sales will be of *radishes* and *spinach.* Long radishes are pulled, and tied in bunches, and then thrown into water. In a few minutes they are taken out by the tops, laid against a board which stands sloping into the water, and there washed clean with a wisp-broom.

The round radishes grow at the top of the ground, and so little dirt adheres to them that they only require to be soaked for a few minutes and then shaken in the water.

Spinach is simply cut off at the top of the root and packed (dry) in barrels—40 lbs. being a barrel. It is the easiest of all the crops, except cabbages, to prepare for market.

Parsnips are, as every farmer knows, either left in the ground until spring, or taken up in the fall and stored like any other roots.

Beets are pulled when about half grown; the outside leaves torn off so as to leave only enough to hold them by securely, the roots washed clean, and tied in bunches of four or five, according to the varying custom of different markets.

Onions (rare-ripes) are pulled when the bulb has a diameter of three-quarters of an inch or thereabouts—the larger the better—and, after the removal of the dead skin, are tied in bunches of five or ten. For the New York market, they must be washed. For Eastern markets this is not necessary. It is quite an addition to the cost of preparation.

Cabbages (the early sorts) are simply cut off near the ground, with nearly all their leaves, and, if they are to be shipped, are packed in barrels or crockery-crates. They will stand a good deal of rough treatment.

Prices of Early Vegetables.—On this subject but little can be said that will be a criterion for different localities, except that in nearly all of the smaller towns they sell for from 50 to 100 per cent. above the New York quotations. The cause of this anomalous condition is that these towns are nearly always supplied with *early* vegetables from the larger cities.

Probably the following may be taken as a fair average of prices in towns of from 10,000 to 50,000 inhabitants, during a series of years:—

Cabbages, 8 cents each.

Onions (rare-ripes), 50 cents per dozen bunches of five each.

Beets, 75 cents per dozen bunches of five each.

Radishes, 30 cents per dozen bunches of about ten each.

Spinach, $1.50 per barrel.

Second Crops.—We have now cleared all of the land except that which is occupied by the parsnips. This produces but one crop during the season, and we have not very much more to expect from the use of the land. Our profit must have come mainly from the early crops. Still, enough may be expected to make a fair return for the labor of cultivation, and for the use of the land and manure, and the land needs to be cultivated for its own sake. The gardeners about the large cities, having a market for everything green that they can raise during the whole year, and for some crops, such as celery and salsify, which meet with no sale in small places, find their second crops very profitable; but, in our case, the chances are that we must be content with small returns from this source.

We are debarred from raising rutabagas, or French turnips, and late cabbages, for the reason that these cannot follow our crop of cabbages, and if they were made to follow any of the other crops they would injure the land for the growth of early cabbages the next year.

Celery is a good crop for land that is in good condition, but it is hardly worth raising for small markets.

Horseradish, *sweet herbs*, *mangel wurzel*, *sweet corn*, and *common turnips* are about the only safe reliance. Of these, the first is the most profitable, as it finds a ready sale among the pickle-makers in cities. Concerning its cultivation, the following is copied from an article furnished by Peter Henderson for the Report of the Agricultural Department for 1865:—

"The culture is very simple, and so far very profitable. The plants or *sets* used are the pieces broken off from the main root in its preparation for market. These are cut into lengths of about six inches, and are from one-quarter to one-half inch in diameter. They are planted *between the rows* of cabbage or cauliflower as soon as these crops are planted in the spring, and about the same distance apart between the plants. The set or root is planted perpendicularly, three inches under the surface. There is no danger in planting the sets thus deep, for horseradish is particularly tenacious of life, and will start and push through the soil even if planted much deeper. The motive in planting it under the surface is to delay its starting, so as not to interfere with the cabbage crop, which may close over it without any injury whatever to the horseradish. It sometimes happens, however, either from planting too near the surface, or by the sets being very strong, that the horseradish grows so strongly as to interfere seriously with the cabbage crop. In such cases it must be cut off by the hoe, and this will not injure it in the slightest degree. We have often had to hoe it off twice before the cabbage crop was ready. It will be borne in mind that it is the root only of this crop that is wanted, and that, being grown mostly in the late summer and fall months, the removal of the leaves in June, or July even, does not in any way affect the crop.

"As soon as the cabbages have been cut off the stumps are dug up, and the ground deeply hoed, so as to encourage the growth of the horseradish crop. This rarely requires to be done more than once, the rapid growth of the leaves smothering all weeds. It attains its full growth of root by the end of October, when it may be dug up; but, being an entirely hardy plant, we usually defer lifting it until all our more tender vegetables are secured, so that the time of digging it up is usually in November and December. It is then placed in pits adjacent to the vegetable house, so that it can be got at conveniently, and trimmed during leisure time in winter. Its preparation for market is very simple, being merely trimming off the small roots (which are kept for next season's planting), washing, by rinsing them around in a large tub; weighing—for it is all sold by weight—and packing in barrels.

"The average weight per acre is four tons, and for the past five years it has sold for $200 per ton, or $800 per acre. During March of last year it sold as high as $250 per ton. I have always considered it the most safe and profitable crop of our gardens."

Whether these results could be obtained if the production of horseradish were largely increased, it is impossible to say; but there is no doubt that its cultivation will remain fairly remunerative.

Sweet herbs are a safe crop to raise, even at a distance from market, as they can be dried and stowed away in a loft until the leisure time of winter allows them to be bunched and packed for shipment. Henderson estimates the average yield per acre at $500.

The varieties usually grown for commercial purposes are thyme, sage, summer savory, and sweet marjoram. The cultivation of all of these is precisely the same.

The plants are raised from seed sown in April in a very fine and rich seed-bed, and they are planted out in the field, at any time after they are large enough up to the last of July, in rows about 12 inches apart, and at somewhat less than this distance in the row. They should be kept free from weeds until they cover the ground. At this stage each alternate row should be cut out, after which the crop will spread and occupy the whole ground again, and in very favorable seasons it will sometimes close up after alternate rows have been taken out a second time.

Mangel-wurzel (or field beet) is a safe crop for the farmer to raise, inasmuch as it is the best of all the roots for cattle food; and, in rich ground, it produces enormously, while it does not interfere with the growth of cabbages the following year.

For a second crop the plants should be raised from seed planted very early in May, and it should be set out at distances of 30 inches by 15 inches. It is a perfectly safe and easy crop to transplant, if care be only taken not to attempt the operation until the roots are at least as thick as the little finger.

The distances recommended as the best ones at which to set the plants are larger than are usual in this country, but on land so rich as that under consideration, the leaves will cover the whole space, and the roots will grow to an enormous size, giving a larger yield than if more thickly set out.

Sweet corn is a fair crop to raise for market, but its cultivation is so well understood by all that it is only necessary to say here that it should follow the spinach and the onions, which are the first out of the ground in June.

Common turnips are the poorest paying of all the articles recommended for a second crop, but they are also raised with very little trouble, and as the seed may be sown at any time in July, they are often available to follow the last removed of the first crops, except the Brunswick cabbages, and these will not usually be cleared off in time to prepare the ground for anything but spinach for the following spring.

Profits.—This is hardly a safe subject for estimate; so much depends on the land, the situation, the man, and the market, that one will gain where another would lose, and the ratio of profits will vary from zero to an almost fabulous amount. However, under any favorable circumstances, a man tolerably well qualified for the business, *provided he will use manure with what he may think a wasteful hand,* might expect about the results of the following table, for an average of ten years.*

Expenses:—

Rent and taxes, say	$30
Interest on cost of improvements and tools, say on $800, at 7 per cent	56
Wear and tear	100
Manure (2 acres)	160
Labor (equal to two men for the whole year)	1000
Seeds and plants	50
Total	$1,396

* The first year, the outlay for manure will be more, and, owing to the crude condition of the soil, the returns will be less.

Receipts :—

From use of 50 sashes, as per previous estimate	$680 00
From 450 tomato vines on the fences (say 25c. each)	112 50
1 acre, 10,000 cabbages at 8c	800 00
3 tons horseradish (2d crop)	500 00
¼ acre beets, 300 dozen bunches at 75c.	225 00
¼ " onions, 500 dozen bunches at 50c.	250 00
¼ " spinach, 50 barrels, at $2	100 00
¼ " parsnips, 200 bushels at 75c	150 00
Radishes from among beets and cabbages, say	100 00
¼ acre sweet herbs (2d crop)	100 00
¼ " sweet corn (2d crop)	25 00
¼ " mangel-wurzel, say 250 bushels at 40c	100 00
¼ " common turnips	25 00
Total	$2,487 50
Deduct expenses	1,396 00
Net profits	$1,091 50

Of course there are chances that the profits will be much less than the above amount, but there are at least equal chances that they will greatly exceed it.

STEAM CULTIVATION.

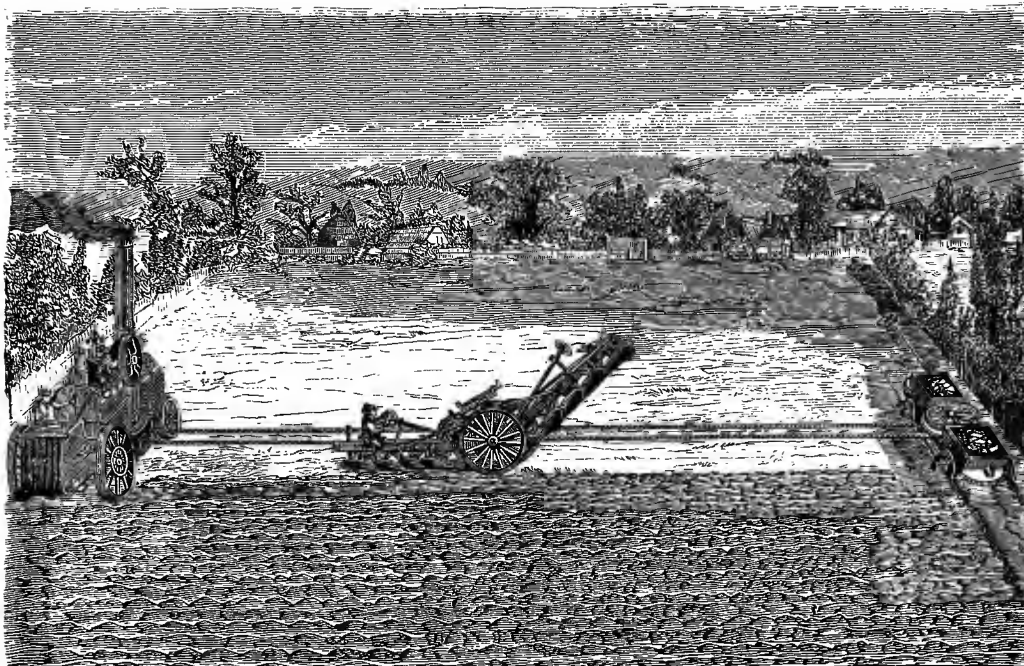
For many years it has been a dream of American inventors to devise some means by which a locomotive steam-engine could be made to take the place of the team in ploughing.

Thus far, although some of the devices have been made to work tolerably well, none of them have achieved such success as to commend them to general use.

It has fallen to the lot of England to make the first application of steam to ploughing that has been so decidedly successful as to come into very general use. They have abandoned the idea of making the steam-engine travel at the front of the plough, and place it on one of the headlands, broadside to its work, an "anchor" standing opposite to it on the other side of the field.

Under the engine there is a horizontal windlass, five feet in diameter, and a similar windlass is attached to the anchor. A steel wire rope passes around these two windlasses, its ends being fastened to the carriage to which the ploughs are suspended, and which forms a link in the endless chain.

The windlass under the engine is so arranged that it clasps the rope firmly on those parts where its pulling force is exerted, and lets go as the rope leaves it in its movement toward the anchor.



FOWLER'S PATENT STEAM PLOW IN OPERATION.

The ploughs are set in "gangs" on a tilting frame. One end of the frame carries right hand, and the other end left hand ploughs. The ploughman sits on the end of the frame which is "in work," and guides the carriage by means of a steering wheel. His weight holds the end on which he sits down to its work, and tilts the other end up, so that its ploughs are in the air. If the width of the field is considerable, "rope porters" or guiding wheels keep the rope from running on the ground, and thus save power and prevent wear and tear.

The ploughs being ready to commence their work at the side of the field next to the engine, this is set in motion and the ploughs are drawn toward the anchor; when they arrive at the anchor side of the field, the ploughman changes his seat to the other end of the frame, and the engine is reversed, drawing the ploughs toward it; and in this manner they are moved back and forth until the whole length of the field is ploughed. They are then moved to the ends of the headlands and these are ploughed.

The engine is a locomotive, and advances along the headland so as to be always opposite its work, and the anchor is moved at the pleasure of the operator, by the action of its windlass.

The ploughs are used in all cases where there is a sod or a long stubble to be turned under, but fallow land is cultivated by the substitution of long-toothed grubbers, which work at a greater depth.

The construction of the steam ploughing apparatus, and its mode of operation, are shown in the illustrations which accompany this article.

Among the advantages claimed for it are the following:—

1. Greater rapidity of work, allowing land to be speedily prepared for the crop while in the proper condition, thus greatly lessening the danger that planting will be delayed by rains.

2. Cheapness of work—the cost (in England) being reduced from about $5 per acre, the cost with horses, to about $1.25, the cost with the steam apparatus.

3. Improved condition of the land.

4. Better drainage.

5. Greater activity in the performance of all the work of the farm.

Concerning *rapidity* of work, it may be stated that a 14-horse engine set will *plough* from 9 to 12 acres per day, and do the work better (deeper) than it can possibly be done with any ordinary farm team.

At the Annual Show of the Royal Agricultural Society at Bury St. Edmonds, in 1867, Fowler's cultivator smashed up light stubble-land at the rate of 50 acres per day of 10 hours, and did the work at a cost of about 25c. per acre, including all charges for fuel, wear and tear, and attendance.

Anything which places it in the power of the farmer to prepare his land for planting at so rapid a rate as even 8 acres per day, must do much to free him from the annoyance of frequent delays from wet weather at a time when it is important that everything proceed rapidly.

The comparative cost of cultivation, when done by steam instead of horses, is, of course, dependent on circumstances. On small farms, and for use in small fields of irregular shape, the cost of maintaining an expensive set of machinery, and the time lost in moving from one field to another, would more than make up for any saving in the actual cost of the work. On farms having 250 acres of land under the plough, and having few fields of less than 10 acres, the saving in cost of work would be very great.

This saving of cost, however, is of minor consequence as compared with the other advantages of steam cultivation.

The improved condition of the land, including its better drainage, is the great argument in favor of the process.

The movement of the ploughs is nearly twice as rapid as that of the horse-plough, and the furrow, instead of simply being turned over, is thrown from the mould-board so rapidly that it is much more thoroughly pulverized. As the furrows are all laid in one direction, there are no dead furrows left when the work is done. In the ordinary ploughing of an acre of land it receives 350,000 foot-marks per acre, one-half of these being upon the earth at the bottom of the furrows, which in time becomes compacted to an almost water-tight condition. In steam ploughing, the land is not touched by a hoof, and when (as is often the case) all the operations of harrowing, rolling, and seed-drilling are done by steam, it is left in a condition most favorable to the growth of the crop, and to the rapid subsidence of water of rains—assuming that the land is either naturally or artificially under-drained.

Not the least benefit of steam cultivation (accompanied by the use of the steam-engine for threshing, grinding, fodder-cutting, &c.) is found in the greater activity which is imparted to all the business of the farm. The same difference, but in less marked degree, is to be observed in the use of horses instead of oxen.

The motive power sets the *time* of the whole establishment, and as the use of oxen leads to a slow, drawling, listless habit, so steam gives an activity and bustle to everything which makes wages and board tell with better effect on the year's performances.

In the Journal of the Royal Agricultural Society, for 1867, there is a very elaborate report of the results of the examinations of the committees which had been appointed "to inquire into the results of steam cultivation in use by 135 farmers and stock companies in England."

The following are some of the conclusions at which they arrived:—

"In nearly all the cases reported it will be seen that the expenses of cultivation are very much reduced, and yet that a larger amount of produce is said to have been realized.

"Not only are the operations themselves better done, quicker done, less expensively done, but all kindred and collateral movements have had imparted to them a speed and 'whirr' characteristic of steam; men acquire the habit of doing the day's work in the day, and of not leaving it for the morrow. The day's labor, too, on a steam farm represents more work with less distress to the physical frame of the laborer, and better remuneration. Steam is working a revolution—slightly manifested as yet, so that we can only speak of tendencies in farm practice, and in the character of the rural population. They are being trained for the era of machinery in agriculture.

"In most cases an increase of produce, in some instances as much as 8 bushels per acre (of wheat), has resulted from steam cultivation.

"We may state as our general conclusion that steam tackle, whether of Fowler, Howard, Smith, or other makers, is now so far perfected and settled in form and details, that it may be classed among old-established, standard farm machinery, and no longer among the novelties of the day.

"We find, as the result of experience, that which we already anticipated theoretically, viz., that the increased depth of surface and the absence of pressure greatly increase the absorbing powers of the soil, and consequently assist the action of the drains.

"Mr. Wm. Smith, of Woolston, England, was one of the pioneers of steam cultivation, and is still one of its most zealous advocates. A short time ago he extended an invitation to all who were interested in the subject to visit his farm and witness the operation of his tackle, and to see its effect. He communicates to a London paper the substance of the statements he made to his visitors, and from this I extract the following, as serving to illustrate the completeness with which the system has been tried and found satisfactory :—

"You must see that these fields are not only heavy clay, but hilly and uneven, and the face of them shows that they are well drained as well as well cultivated.

"This field, No. 3, on which you stand, together with No. 2, through which you have passed, and No. 1 (light land), which I will hereafter show you, contain 32 acres, and were smashed by steam-power on the 31st of August, and the 1st, 2d, and 3d of September, at the following cost :—

Labor	£3	14	0
Coal	1	12	0
Oil		2	6
Interest on money, and wear and tear	2	9	6
	£7	18	00

Or 4*s.* 9*d.* per acre (about $1.15).

* * * * * * * * * * *

"Now I will let you know what the operations and cost of seed-beds have been on these four fields under steam culture for 14 years, taking those on field No. 3 to represent the lot :—

"10 steam-power smashings, 2 ridgings and subsoilings by steam-power, 2 cultivatings and drillings at one operation, each by steam-power; 1 cross cultivating by steam-power, 1 cross cultivating and seeding at one operation by steam-power, 7 horse cultivatings, 1 horse subsoiling, 1 ridge ploughing by horses. The total cost of these operations has been £6.11.9, or 9*s.* 5*d.* per acre as the average cost of a seed-bed, exclusive of planting or drilling, except those planted by steam-power.

"The cropping on No. 3 during that period has been 1 of peas, 2 of barley, 5 of beans, 5 of wheat, and 1 of Swedes.

"The average yearly produce under steam culture has been, on these four fields, quite 14 bushels per acre more than it had been under horse culture.

* * * * * * * * * * *

"Now let us look into the working of the tackle since the 5th of October last. On that day I started it on No. 4 (heavy land), 10 acres, ridging and subsoiling it for beans. It was finished on the 6th at 4.10 P.M. The depth of work is 9 inches; the consumption of coal 1 ton; and the pressure on the engine 60 lbs.

"We then shifted the tackle nearly half a mile to No. 1 (heavy land), 8 acres, and we finished that field at 12.15 P.M. on the 8th. Depth of work 10 inches; consumption of coal 16 cwt.; pressure on the engine 65 lbs.

"We then shifted the tackle a quarter of a mile to No. 3 (light land, part 1), 5 acres, and finished it on the 9th at 12.20 P.M. Depth of work 10 inches; consumption of coal 9 cwt.; pressure on engine 60 lbs.

"We then shifted the tackle a mile to No. 6 (light land), 14 acres, working all day on the 10th (the 11th was Sunday), working again all day on the 12th, and we finished on the 13th at 8.40 A.M. Depth of work 11 inches; consumption of coal 29 cwt.; pressure on engine 65 lbs.

"We then shifted the tackle more than a mile to No. 3 (light land, part 2), 6 acres, and finished it on the 14th at 11.50 A.M. Depth of work 10 inches; consumption of coal 10 cwt.; pressure on engine 60 lbs.

"We then shifted the tackle to where it now stands, on No. 4 (light land), for you to see it at work.

* * * * * * * * * * *

"It is not a set of new-fangled tackle, got up for the purpose of racing, for the common portable engine has done 10 years' hard work. It has done, in addition to my ploughing, a lot of threshing and grinding, yet it is in capital trim. The cost of repairs has been but a mere trifle.

"The windlass has had 10 years' work. In 1858 it did 55 acres for the late Prince Consort, on the Flemish farm, Windsor, and I have worked it on my farm ever since.

* * * * * * * * * * *

"I have worked the rope 7 years. The first year it got out several times. At one or other of the splices it pulls in two; indeed it has not, during these 9 days' work, gone through a day without a break; therefore the men have had the mending of the ropes to do as well as the ridging and subsoiling. * * * *

"My average quantity of work per day is much greater, and my average consumption of coal per acre is much less, than it has ever been before. This is mainly due to my land having been deeply worked so many times before.

"The sum total of all this evidence proves plainly that the Woolston system of applying steam-power to the cultivation of the soil gives clean dress and cheap seed-beds, and that fancy tackle is not needed on show days. The boy that you see working the implement is only 14 years old. He has done all my work this year, and well too. The work is before you to speak for itself."

It is found, for use in neighborhoods where the farms are small, that it is the best plan to form joint-stock companies to own and operate the tackle—hiring it out by the day or by the acre, and giving the precedence to stockholders. This plan would work the best among the smaller farmers of our Eastern States—but at the West, where the proprietorships are larger, it will be most advantageous to have the apparatus, with its engine to do other work, attached to the farm.

It is sometimes objected that much of the land in this country is too rough and too stony for the steam-plough ever to gain a foothold. The same objection was made twenty years ago to the use of the mowing machine in New England, and there is every reason to suppose that when the advantages of the steam-plough are once fully realized, even the hillsides of Vermont will smile under its influence.

HOUSE PAINTING.

The following receipts and directions are condensed from a practical English work on the art of house painting. They are principally designed for the inexperienced and those who, living at a distance from cities, have great difficulty in obtaining first-class workmen.

To make the work satisfactory, it is very necessary for the workman to have *very clean* all the vessels, brushes, and cans he may require in the course of his work, such as the various paints, pots, or vessels in which he mixes or from which he uses his colors. These are sometimes bought at the shops, handsomely made of stout tin, and such are easily kept clean, and save their expense in color, which is readily brushed down their smooth sides. He will also require a marble slab and muller, to grind the finer colors used in painting. Sometimes a small cast-iron mill is useful not only to grind colors, but to pass the tinted color through, so that it may be more thoroughly mixed.

It is presumed the workman will know what brushes he will require, according to the work he has in hand.

In preparing to paint a good dwelling, after having obtained the necessary colors and brushes, see that you have a few pounds of good pumice stone, a quire or two of assorted sand paper, to smooth the inequalities in the work; some twenty pounds of putty, to stop up after the first coat in every part of the house; a sufficiency of fine slaked lime, and a proper number of large and small vessels, to mix the colors in and use it from; a few pounds of soaked glue, &c.

If the wood-work be new, and no wall work required, you will go over it carefully with a small brush, and some of the glue size, colored with red lead, covering what knots and stains may appear in the wood, after which the priming coat of almost all oil, and good white lead, tinted with Indian red, should be evenly brushed over the work; and, as soon as dry, the putty knife and putty should follow, to stop all the cracks and nail holes. Then should follow the second coat, with a little spirits of turpentine in the oil, and the color slightly tinged with blue black. This is generally thought sufficient for the attic and third stories. But the rest of the house is usually finished with old ground white lead, thinned with spirits of turpentine. The roof, if covered with tin, should be painted once in three years. There are many different methods in use. Some paint with raw oil, dry Spanish brown and a little red lead, to dry it, for fear of a rain; others, with Spanish brown, more red lead, and half whale oil with the linseed oil; others use yellow ochre and black, mixed in the same oils; others use a roof paint, made by boiling paint skins in whale oil, and carefully straining them while warm, reserving the remaining skins, to stop the leaks around chimneys and dormer windows. This last mentioned paint is probably serviceable from its elasticity. In the country, many paint their roofs and out-buildings in the same way, using sometimes Venetian red from its brightness.

Many complaints are continually made that white lead, and colors composed thereof, do not endure, and are quickly beaten off by exposure to the sun and rain. This difficulty occurs as much from the manner of using the paint as from its quality. As this occurs in outside work, it is to be attributed, first, to the condition of the work to be painted, being generally in such a state as to absorb the oil from the first coat, thereby leaving it in a dusty state, and liable to be washed of by the first rain. This can be guarded against, only by filling the old work, in painting two thin coats over it, one upon the other, as soon as dry; and finishing it with one thicker coat, to protect it and shed the rain. A fourth coat, if the immediate expense is not heeded, will repay its cost in additional service and beauty.

The white lead can be procured of any requisite quality at the color stores. It is thought that the best article is the most economical, as it works out with more ease, and repays the difference of cost in its appearance. Linseed oil is also better for having due age, for the same reasons as the white lead, working with softness and advantage after parting with the water which is generally combined with new oil.

The quality and fineness of the white lead used adds materially to the work, and that which is well ground, and has such mellowness from age as will cause it to work smoothly under the brush, in connection with good linseed oil, will certainly repay any reasonable additional cost. The first coats should always be mixed with clear linseed oil; the fourth coat may be used with boiled oil and one-quarter part spirits of turpentine.

Putty is best purchased at a good color store, where you can depend upon its being made of good dry whitening and linseed oil. It should be carefully and freely used after the work has had one coat of paint, for the fresh paint holds the putty very firmly.

Harmony of Colors.—Red looks well with blacks, whites, or yellows. Blues harmonize with whites and yellows. Greens, with whites, black or yellow. Gold, with blacks or browns. White appears well with any color. Purple, pink and white, &c., &c.

MIXING PAINTS.

A Beautiful White Paint.—For inside work, which ceases to smell, and dries in a few hours. Add one pound of frankincense to two quarts of spirits of turpentine; dissolve it over a clear fire, strain it, and bottle it for use; then add one pint of this mixture to four pints of bleached linseed oil, shake them well together, grind white lead in spirits of turpentine, and strain it, then add sufficient of the lead to make it proper for painting; if too thick in using, thin with turpentine, it being suitable for the best internal work on account of its superiority and expense.

For a Pure White Paint.—Nut oil is the best; if linseed oil is used, add one-third of turpentine.

To Mix Common White Paint.—Mix or grind white lead in linseed oil to the consistency of paste, add turpentine in the proportion of one quart to a gallon of oil; but these proportions must be varied according to circumstances. Remember to strain your color for the better sorts of work. If the work is exposed to the sun, use more turpentine for the ground color to prevent its blistering.

For Knotting.—Mix white or read lead powder in strong glue size and apply it warm.

Common Flesh Color.—Stain your white lead with red lead, and mix with oil and turps.

Fine Flesh Color.—Is composed of white lead, lake and vermilion.

A Beautiful Color for Carriages, &c.—Mix carmine lake with black japan.

Cream Color.—This is a mixture of chrome yellow, the best English Venetian red, white lead, and red lead, in oil.

Pearl Gray.—White lead, with equal portions of Prussian blue and lampblack, mix with oil and turps.

Fawn Color.—Grind some burnt and raw terra sienna very fine. Two or three pounds of this is sufficient to stain white lead for a large building. This color is of a superior shade, and very excellent for inside work.

Blue.—Grind Prussian blue in turps; other blue very fine in linseed oil, and mix it with white paint to the tint required.

Buff.—This is a mixture of French yellow, chrome yellow and white lead, tinged with a little Venetian red, oil and turps.

Straw.—A mixture of chrome yellow and white lead, oil and turps.

Drab.—Raw and burnt umber and white lead, with a little Venetian red, linseed oil and turps. *Another.*—Burnt umber and white lead, with a little Venetian red, oil and turps, as before.

Steel.—Mix white lead, Prussian blue, fine lake and verdigris, in such proportions as to produce the required color.

Purple.—White lead, Prussian blue and vermilion, or lake, with oil and turps.

Violet.—Is composed of vermilion, mixed with blue-black, and a little white.

French Gray.—White lead and Prussian blue, tinged with vermilion; and for the last coat substitute carmine for the vermilion. Mix with oil and turps.

Silver.—Use white lead, indigo, and a small portion of blue-black, as the shade may require.

Gold.—Mix Naples yellow or patent yellow with a small quantity of orange chrome and a little Spanish white.

Dark Chestnut.—Mix red ochre and black. Use yellow ochre when you require to lighten the color, in oil.

Salmon.—White lead. tinged with the best English Venetian red, oil and turps.

Peach Blossom.—White lead, tinged with orpiment; mixed with oil and turps.

Drab.—White lead with a little Prussian blue and French yellow, linseed oil and turps. *Another.*—White lead, with a little French yellow and lamp-black, linseed oil and turps. *Another.*—White lead with a little chrome green and blue-black.

Lead.—This is a mixture of lamp-black and white lead, with a little litharge.

Chocolate.—Mix lamp-black and Venetian red with a little red lead, or litharge, to harden the color and give a drying quality. The colors must be ground, and mixed with boiled oil and a little turps.

Dark Red, for Common Purposes.—Mix English Venetian red in boiled oil with a little red lead and litharge, to give a drying quality.

Orange.—Mix red lead and French yellow with linseed oil and turps, or use deep chrome yellow.

Bright Yellow for Floors, &c.—White lead and linseed oil, mixed with some French yellow, and a little chrome yellow to brighten it; some red lead, burnt white vitriol and litharge added to give it a very drying quality. This color mixed with equal parts of boiled oil and turpentine, and used very thin.

Dark Yellow.—Mix French yellow in boiled oil, adding to it a little red lead and litharge, to give the paint a drying quality.

Light Yellow.—This is a mixture of French yellow, chrome yellow and white lead, with oil and turps. *Another.*—French yellow, white lead, and red lead. *Another.*—Grind raw terra sienna in turps and linseed oil; mix with white lead. If the color is required of a warmer cast, add a little burnt terra sienna ground in turps.

Olive Green.—A suitable, cheap, and handsome color for outside work, such as doors, carts, wagons, &c.

Grind separately Prussian blue and French yellow in boiled oil, then mix to the tint required with a little burnt white vitriol to act as a drier. *Another.*—Black and blue mixed with yellow, in such quantities as to obtain the colors or shades required. For distemper, use indigo and yellow pink mixed with whiting or white lead powder. *Another.*—This is a mixture of Prussian blue, French yellow, a small portion of Turkey umber, and a little burnt vitriol. Ground the same way. *Another, in oil.*—Mix Prussian blue and chrome yellow. Grind the same. *Another shade.*—A mixture of Prussian blue and French yellow, with a small quantity of white lead and Turkey umber and burnt white vitriol. Grind the same.

Light Green.—White mixed with verdigris. A variety of shades may be obtained by using blue and yellow with white lead.

Grass Green.—Yellow mixed with verdigris. *Another.* —Mix one pound of verdigris with two pounds of white lead. Walnut oil is the best for this purpose.

Invisible Green, for outside work.—Mix lamp-black and French yellow, with burnt white vitriol. These colors mix in boiled oil. Burnt vitriol is the best drier for greens, as it is powerful and colorless, and consequently will not injure the color.

To Paint a Bronze.—Grind good black with chrome yellow and boiled oil; apply it with a brush, and when nearly dry use the bronze powder at certain parts and the edges also; the effect will be a brassy hue.

A Good Imitation of Gold.—Mix white lead, chrome yellow, and burnt sienna, until the proper shade is obtained.

Tar Paint for Fences, Roofs, &c.—Common tar mixed with whiting. Venetian red or French yellow, according to the color required. This should be warmed in a large iron kettle in the open air, and applied with a large painting-brush. It is an excellent preservative of the wood, and looks well for rough work.

Paint Driers.—*Litharge.*—This is a useful drier, and may be used in all kinds of paints, except greens and very delicate colors. *White Vitriol or Copperas.*—This turns into water, especially when used in black paints; and is almost useless for any color till the water of crystallization is evaporated, and then it becomes a powerful drier, and may be used for every delicate color, as it is perfectly transparent; but when used in its raw state in white paint, has the effect of turning it yellow. *Sugar of Lead.*—This is a very useful and transparent drier, not so powerful as white vitriol, but it may be used with it to advantage.

Milk Paint for In-door Work.—The quantity for one hundred square feet:—One quart of skimmed milk, three ounces of lime, two ounces of linseed or poppy oil, one pound and a half of Spanish white or whiting. Put the lime into a clean bucket, add sufficient of the milk to slake the lime, add the oil a few drops at a time, stirring the mixture with a flat stick till the whole of the oil is incorporated in the mass; then add the remainder of the milk, and afterwards the Spanish white or whiting, finely powdered, and sifted gently over the mixture by degrees. Curded milk will do for the purpose, but it must not be sour. One coat of this will do for ceilings and staircases in general; two coats or more for new wood. Where color is required, you may use powdered umber, ochres, chromes, greens, blues, pinks, &c., &c., ground in milk. For particular work, strain the color through a hair sieve.

Lime Whitewash.—Lime whitewash is made from lime well slaked. Dissolve two pounds and a half of alum in boiling water, and add it to every pailful of whitewash. Lime whitewash should be used very thin, and when it is sufficiently bound on the wall by means of alum, two thin coats will cover the work better; this may be used for the first coat, thinned with water. Most whitewashers apply their wash too thick, and do not mix a proportionate quantity of alum to bind it, consequently the operation of the brush rubs off the first coat in various parts and leaves an uneven surface, and the original smooth surface of the wall is entirely destroyed.

Italian Marble.—This looks bold, and is well adapted for columns, &c., and is easy to imitate. The ground a light buff. For the graining colors, prepare a rich, warm buff, made in the following manner: Mix stiff in boiled oil white lead and good stone ochre, and tinge with vermilion, then grind some burnt terra sienna very fine in burnt oil, and put it into another pot; mix some pure white stiff in oil, and keep this separate. Thin these colors with turpentine, have ready a brush for the buff, and another for the terra sienna. Proceed to work as follows: Take the brush intended for the buff moderately full of color, and dab it on freely and carefully in different patches, some of them larger than others, and varying them as much as possible. When these are laid on, take the other brush and fill in with the terra sienna the spaces between; as soon as this is done, take a dry duster or softener and blend the edges together, making it appear as soft as possible. Proceed in this manner till the whole is finished, then take a hair pencil and draw a few thin white veins over the work, varying them as much as is necessary; take another pencil for the terra sienna, and run a few thin lines intermixing with the whole; varnish when dry.

To Imitate Granite.—For the ground color, stain your white lead to a light lead color, with lamp-black and a little rose-pink. Throw on black spots with a graniting machine, a pale red, and fill up with white a little before the ground is dry.

A Cheap Oak Varnish.—Two quarts of boiled oil, one and a half pound of litharge, three quarters of a pound of gum shellac, one ounce of gum. All boiled together, and stirred up till dissolved, then take off the fire and add two quarts of turps. When settled, strain into a bottle and cork for use.

Common Oil Varnish.—Take one gallon of quick drying oil, two pounds of resin, and one quart of turpentine; put the resin with the drying oil into a varnish kettle, and let it dissolve in a gentle heat; take it from the fire and gradually pour in the spirits of turpentine. If too thick add more of the turpentine.

Transparent Varnish for Pictures.—Take the white of four eggs and two ounces of loaf sugar; beat them up in lime water to the proper consistency for varnishing.

For Varnishing on Wood, Unpainted.—Quarter of a pint of wood naphtha, quarter of a pint of spirits of wine, four ounces of benzoin, four ounces of orange shellac, added all together. If not thick enough with those ingredients for your purpose, add more of the gums benzoin and shellac.

Waterproof Varnish, for Linen or Calico.—One pint of turpentine, one and a half pint of linseed oil, seven ounces of litharge, one ounce of sugar of lead. Strain it, apply it with a brush, and dry it in the sun or in a warm place.

Instructions.—Oil of turpentine deadens the color of paints; varnishes, copal, &c., brighten the color.

SOLDERS.

For lead solder.—Melt 1 part block tin, and when fused, add 2 parts of lead. Use resin with it.

For tin solder.—Melt 4 parts of pewter, 1 part of tin, and 1 part bismuth together. Use resin with it.

CEMENTS.

Glue.—Melt 1 lb. glue in 2 quarts warm water. For a glue that will resist the action of water, boil 1 lb. of glue in 2 quarts of skimmed milk. Pulverized chalk added to glue strengthens it.

Soft cement.—For boilers, steam-pipes, &c.: 4 parts red or white lead, ground in oil, with 2 or 3 parts iron filings.

Hard cement.—Mix iron borings or filings with salt water, then add a small quantity of sal ammoniac with water.

Hydraulic cement—for cisterns, sewers, cellars, pipes, &c., is purchased by the barrel, which contains 300 lbs.

Dry cement—which will resist the weather equal to marble, is made of 2 parts sifted ashes, 3 parts clay, and 1 part sand, mixed with oil, and applied while soft.

Brown mortar, for masonry, brick-work, &c.

Mix 1 part lime, 2 parts sand, a small quantity of hair with water.

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